Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

NOVEMBER, 1950

TECHNOLOGY DEPT.

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How TIMKEN® bearings keep ladle cars working longer with less maintenance

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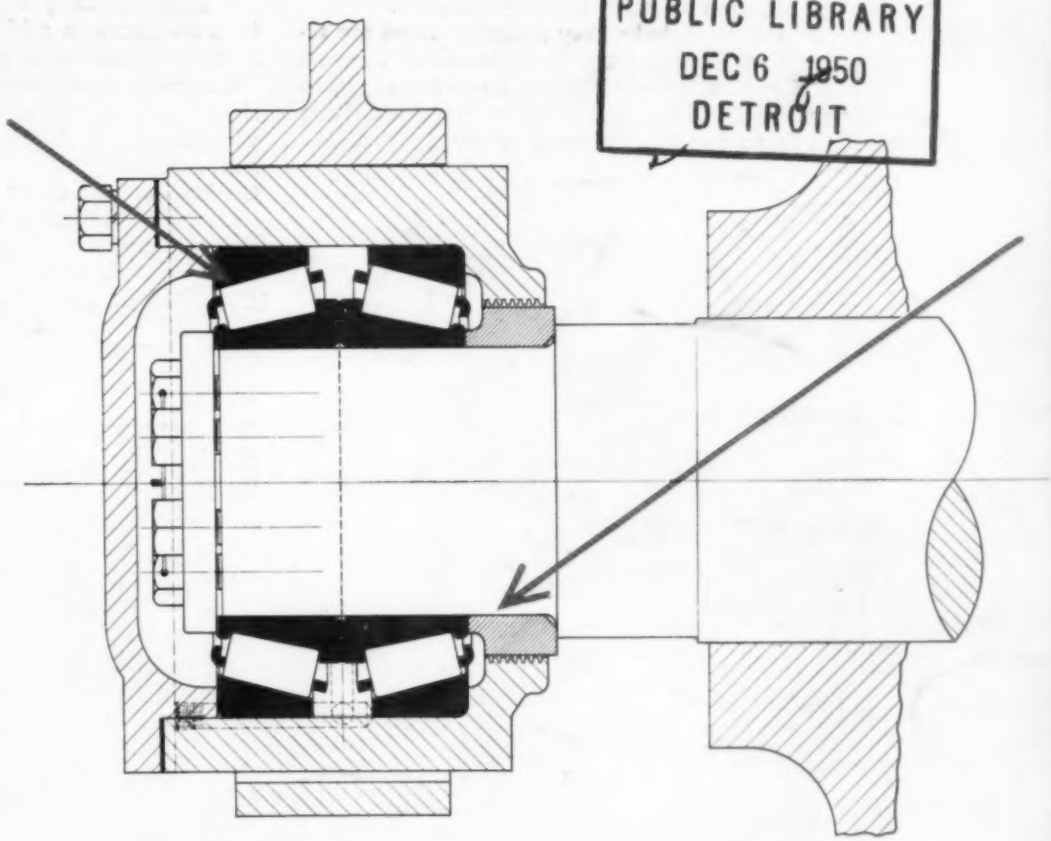
DETROIT

THIS Timken® bearing equipped ladle car journal is the answer to two big problems: (1) How to get maximum service from ladle cars, (2) How to cut maintenance costs. Timken tapered roller bearings eliminate axle wear, reduce starting resistance 88% of that of friction bearings. No thrust bearings or washers are needed. Lubrication can be kept to a minimum.

Because Timken bearings are precision manufactured and finished to incredible smoothness, friction is virtually eliminated. Their tapered design enables them to take any combination of radial and thrust loads. Line contact between the rollers and races of Timken bearings gives them extra load carrying capacity. Made of Timken fine alloy steel, they're case hardened to take even the toughest shock loads. And thanks to the advanced design of Timken bearings, tighter closures are permitted. Lubricants are retained longer, reducing maintenance time and material costs.

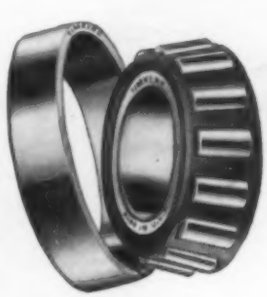
The many advantages of Timken bearings have been proved over and over in all types of railroad applications. No other bearing has so much to offer . . . no other bearing is so fully proved. Call on our Engineering Staff to help you solve your bearing problem. Write The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".



TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◫ AND THRUST →◫← LOADS OR ANY COMBINATION →✳←

why there can be

NO OTHER ANSWER IN SAFETY SWITCH SELECTION

Engineering research authenticated by outstanding authorities has conclusively established "internal heating" to be the principal cause of safety switch failures. This "internal heating" literally bakes the life right out of safety switch parts, causing insulating materials to disintegrate and metal parts to distort and corrode. The safety switch then either becomes inoperative or it "burns up" through inability to carry the load.

In properly constructed safety switches, fuses are almost entirely responsible for this destructive "internal heating." This is not a criticism of fuses for *any* fuse operating up to its rated load *must* be near its melting point if it is to perform properly when an overload occurs. And any metal operating *near* its melting point *must* be hot . . . and fuse links are *hot* . . . with temperatures running as high as 700 degrees Fahrenheit.

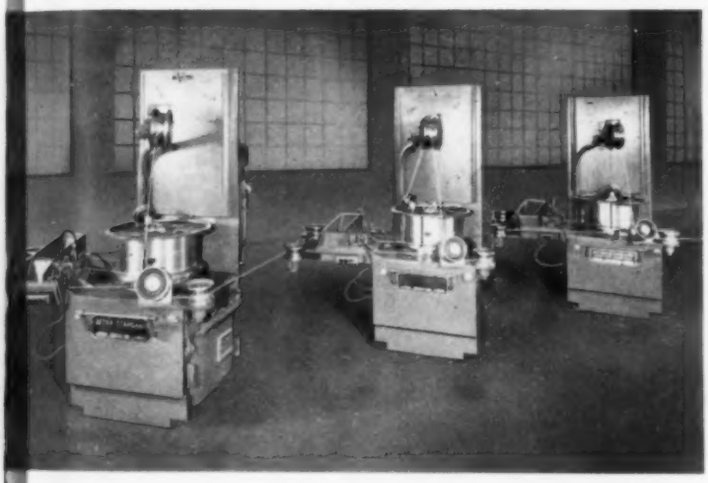
Since you cannot vent trapped heated air through a safety switch enclosure and still keep a safety switch *safe*, the only escape from the ravages of "internal heating" *must* come through the selection of materials for the internal safety switch structure and the design of that structure to *withstand successfully the unavoidable heat conditions met in safety switch service.*

Cutler-Hammer Safety Switches were completely redesigned in this way *ten years ago* to beat "internal heating" when engineering research clearly indicated the need for *such* safety switches. Nine years of experience shows the Cutler-Hammer claim of better safety switch performance far more than a mere promise; it is a proven *fact* that demonstrates why there can be no other answer in safety switch selection. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wisconsin.

CUTLER-HAMMER
SAFETY SWITCHES
C-H

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 27, No. 11.

aetna-standard wire drawing unit



SIGNIFICANT ADVANTAGES AND FEATURES

1. Compactness and sturdy construction with vertical block and vertical motor on each unit.
2. Unit parts can be interchanged.
3. Vertical motors easily accessible and interchangeable.
4. Controlled, effective water-cooling of blocks and dies.
5. Practical versatility by tandem combinations of two or more Units of the same or different size.
6. Full speed range of each Unit motor always available with the unique auto-rheostatic synchronizing control mechanism.
7. Automatic control of reserves of wire on intermediate Units, offers these advantages:
   (a) additional cooling time and effect between drafts.
   (b) eliminates peripheral slippage of wire on blocks.
   (c) broken intermediate wires can be welded easily.
   (d) reduces wire breakage during starting or acceleration.
   (e) avoidance of extreme sensitivity in auto-rheostatic control.
8. Insurance against obsolescence—Aetna Units can be regrouped by addition of single Units, multi-Units or divisions of multi-Units to keep pace with future wire production or market demand.

UNIT SIZES	BLOCK DIAMETERS		
No. 30	26"	30"	36"
No. 22	16"	22"	26"
No. 16	12"	16"	22"
No. 12	8"	12"	16"

ASSOCIATED COMPANIES

Head Wrightson Machine Company, Ltd., Middlesbrough, England—Great Britain, Finland, Sweden, Norway, Denmark, Union of South Africa, Northern and Southern Rhodesia.

Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.

M. Castellvi, Inc., New York, N. Y.—Mexico, Central and South America.

Societe de Constructions de Montbard, Paris, France—France, Belgium, Holland, Luxembourg, Switzerland.

Compagnia Italiana Forme Acciaio, Milano, Italy—Italy.

Aetna-Japan Company, Ltd., Tokyo, Japan—Japan.

Hale & Kullgren, Inc., Akron, Ohio—Representative for the Rubber Industry.

aetna-standard

THE AETNA-STANDARD ENGINEERING COMPANY . YOUNGSTOWN, OHIO

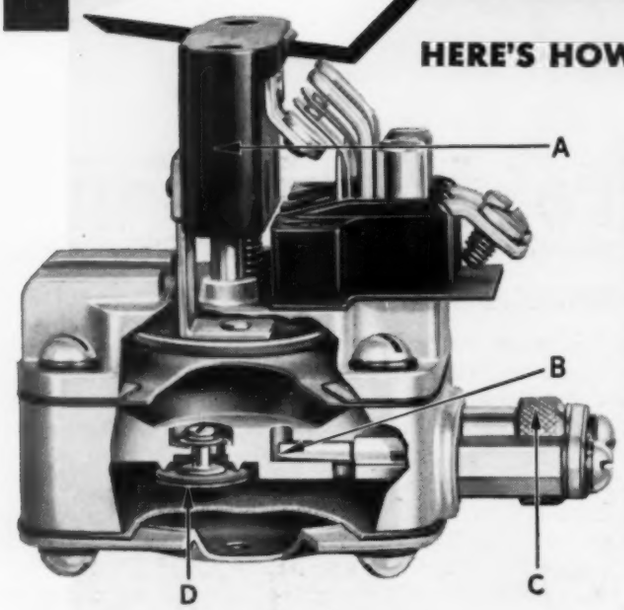
Plants in Warren, Ohio . Ellwood City, Pennsylvania

Designers and Builders to the Ferrous, Non-Ferrous, Leather and Rubber Industries

PNEUMATIC TIMERS Do It Better

ACCELERATE MILL MOTORS ... and CONTROL AUTOMATIC PROCESSES

HERE'S HOW THEY WORK



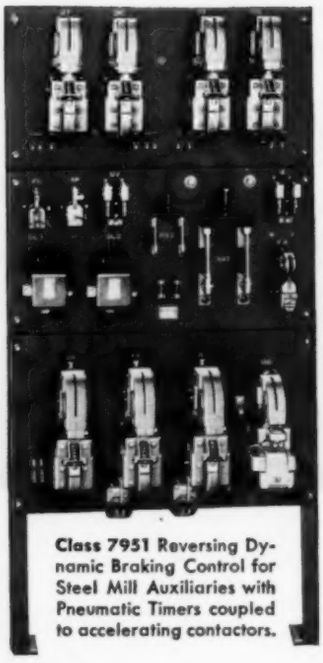
Timing head can be coupled to a contactor or actuated by separate magnet. Contact member (A) is normally pushed down against compression spring. When contact member is released, a rubber diaphragm is flexed upward, drawing air from lower chamber to upper chamber through metering orifice (B). Rotation of the knurled wheel (C) advances or withdraws pin to give wide range adjustment. Air returns through valve (D) for instantaneous reset. Lower diaphragm is double layer felt.

Square D's PNEUMATIC TIMERS, a product of over 15 years' experience in many difficult fields of application, offer these proven design and performance features:

- **Extremely accurate**
- **Adjustable over wide range**
- **Unaffected by dust or usual fluctuations in voltage or temperature**
- **Dependable over long periods of severe service**
- **Simple, flexible and easily applied**
- **Attached to contactors or actuated by separate magnet**

• Accurate, fixed timing insures uniform motor acceleration under all conditions of application. Operators are able to obtain closer control by anticipating machine response. Unusually wide range adjustment permits choice of timing period to cover any acceleration requirement.

Processing of steel and associated materials consists of many individual operations performed in timed sequence. (For example—the interval allowed for dumping a blast furnace skip bucket before the hopper rotates.) Pneumatic timers are available for time-delay making or time-delay breaking of a circuit after either energization or de-energization of contactor or separate magnet. Their use in an automatic control circuit simplifies equipment and provides the accuracy and reliability essential to efficient performance.



Class 7951 Reversing Dynamic Braking Control for Steel Mill Auxiliaries with Pneumatic Timers coupled to accelerating contactors.

***Write** for Bulletins 7950 and 9050 which contain information on the Pneumatic Timer and its uses. Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin.*

SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

SQUARE D COMPANY CANADA LTD., TORONTO • SQUARE D de MEXICO, S.A., MEXICO CITY, D.F.

Increase

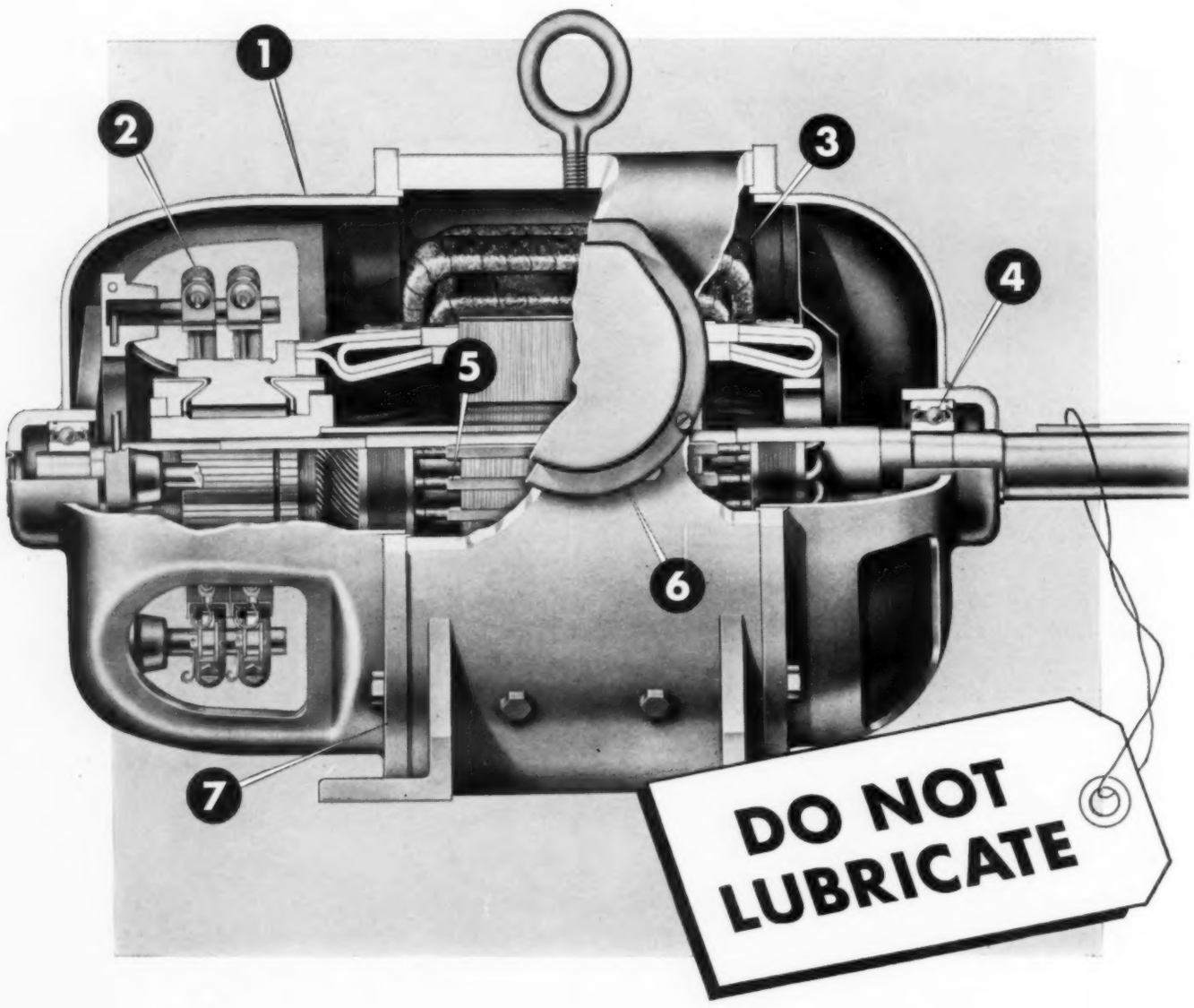
Cold Mill Production with . . . MESTA-THOMSON FLASH WELDERS

Mesta-Thomson Flash Welder installed in a Mesta High-Speed Continuous Pickling Line

MESTA MACHINE COMPANY
PITTSBURGH, PA.
Designers and Builders of Complete Steel Plants

YOU CAN BE **SURE**.. IF IT'S

Westinghouse



1. ALL-STEEL BRACKETS
2. INDIVIDUALLY REMOVED CAST BRASS BRUSHHOLDERS
3. SHELL-WOUND FIELD COILS
4. DOUBLE-SEALED PRE-LUBRICATED BALL BEARINGS
5. HEAVY-DUTY PRESHAPED ARMATURE COILS
6. STEEL-GASKETED CONDUIT BOX
7. ROLLED-STEEL FRAME

If you figure LIFE-COSTS . . . you'll figure LIFE-LINE

SK DEPENDABILITY
Wrapped in Steel
in the NEW Life-Line D-C MOTOR

Thirty-nine years at hard labor—in steel mills . . . in mines . . . in a thousand and one applications—have proved the dependability of the type SK d-c motor. Now, new dependability has been added—new motor stamina . . . new freedom from maintenance . . . new value for d-c motor users.

MAXIMUM STRENGTH AND RIGIDITY—Heavy steel end brackets and rolled-steel frame stand up to the shocking, jarring blows so often encountered in rugged d-c service.

SIMPLIFIED SERVICING—Readily accessible through spacious opening in front bracket, brushholders may be removed individually. Armature coils, wound from Tufvar wire and treated in Thermoset varnish assure long life . . . reduce trouble from shorts and grounds. Double-sealed pre-lubricated bearings (proved in over half a million motors) put an end to greasing problems.

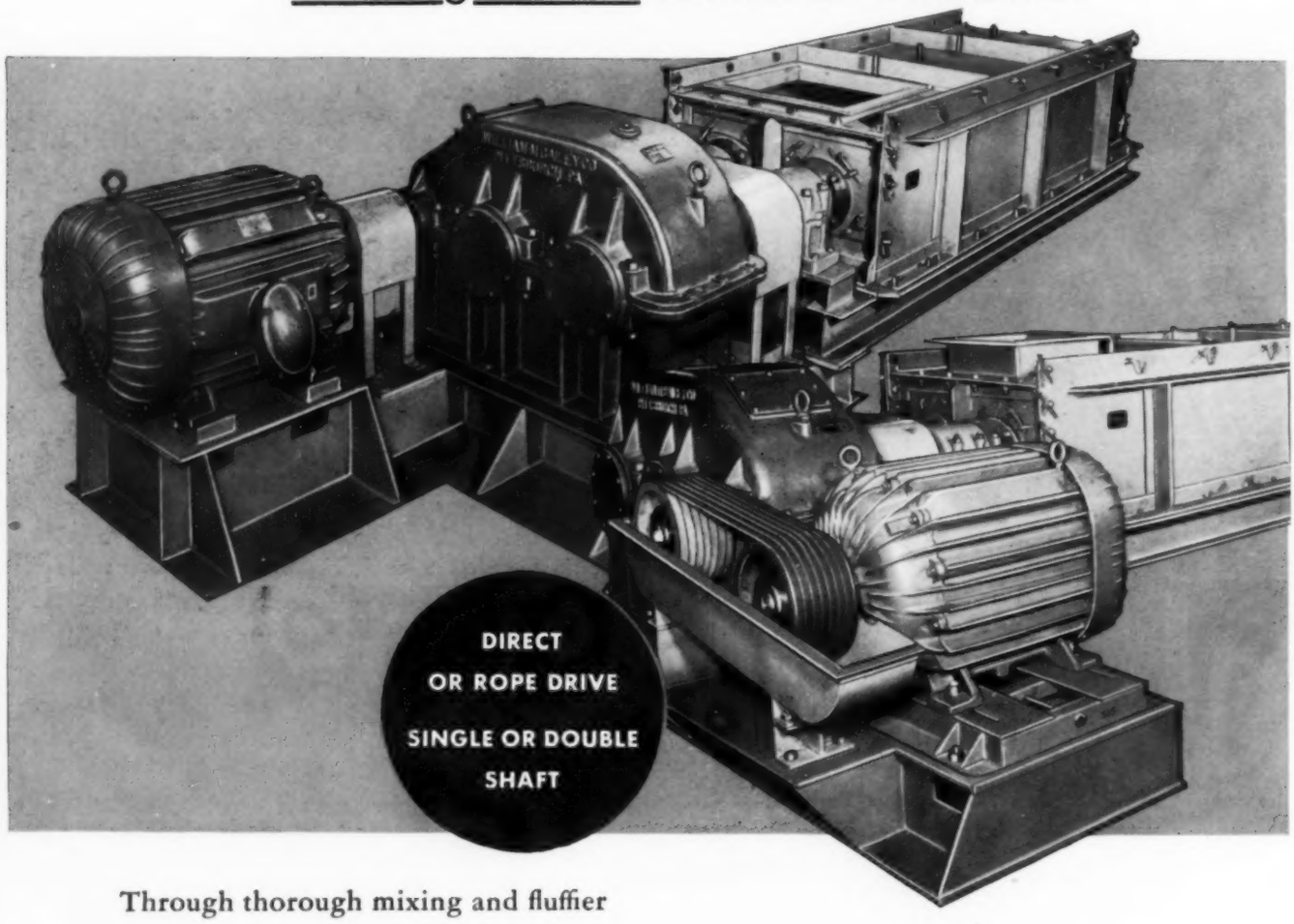
INDIVIDUAL FIELD COIL UNITS—One coil may be replaced without expense of replacing all . . . or discarding pole piece. Just slip the new coil in place . . . save repair costs.

These are a few highlights of the new, all-steel Life-Line type SK d-c motor. Get the complete facts on series, shunt, or compound motors . . . frames 203-365 . . . in 1 to 30 hp ratings. Contact your local Westinghouse representative. Ask for a copy of "D-C Motor" Booklet B-4595, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21549

Westinghouse
Life-Line
D-C Motors

Bailey SINTERING PLANT PUG MILLS

PERMIT A *more uniform,*
***better grade of* SINTERED PRODUCT**



Through thorough mixing and fluffier material, the Bailey Sintering Plant Pug Mill produces a *better* sintered product. With this machine, a higher bed can be used without increasing the wind box vacuum. The result is greater tonnage of more uniform, better grade materials.

These mills can be built to any desired capacity, direct or rope drive, single or double shaft.

Send for new bulletin giving full information on all Bailey Pug Mills.

WILLIAM H. Bailey COMPANY
ENGINEERS
LEADERSHIP THROUGH QUALITY
1221 BANKSVILLE ROAD PITTSBURGH 16, PA.

Now—One grease will service all grease applications in the majority of plants

Gives ALL THESE PLANT SAVINGS:

1. **Extends TIME between greasings**—lasts longer . . . stays in bearings longer.
2. **Low-cost application**—fewer servicings and *only the one grease* to handle.
3. **Simple inventory**—Shell Alvania Grease replaces up to 20 brands formerly required.
4. **Better protection**—against heat, cold and moisture.
5. **Greater safety**—less chance of applying the wrong grease!

Gives ALL THESE LUBRICATION ADVANTAGES:

1. **Higher mechanical stability** than any conventional grease at operating temperatures.
2. **Pumpable at low temperatures**—even in unheated storage.
3. **Stable at high temperatures**—superior to the best "soda" greases.
4. **Impervious to water**—excellent resistance to washing out.
5. **Longer service life**—reduced consumption.

The "MILLION-STROKE" Industrial Grease!

A grease that will stand 100,000 punishing strokes of the ASTM Work Tester has been considered a superior lubricant.

In a deliberate attempt to break down Shell Alvania Grease, *on the same tester* the run was extended...200,000 strokes...300,000 strokes . . . 500,000 strokes! Finally, at one million strokes the test was discontinued, because this grease *would not break down*—it was still a fit lubricant both in appearance and consistency.

SHELL OIL COMPANY

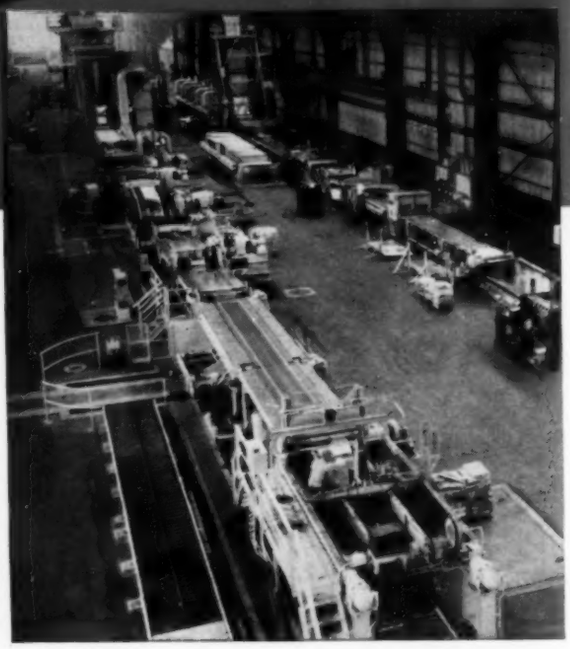
50 West 50 Street, New York 20, N. Y. • 100 Bush Street, San Francisco 6, California

SHELL®

SHELL ALVANIA . . . The "MILLION STROKE" Grease

G-E drive for 48" continuous annealing and galvanizing line -helps speed production of uniform-quality light-gage strip!

General Electric engineered drive and furnace handles .012 to .040 strip at speeds from 50 to 300 fpm, for output up to 10 tons per hour!



Co-ordinated G-E control in this line keeps output high, operating costs down, with features like these: 1) loop-filling-and-emptying control that permits maximum loop storage, protects against shutdowns; 2) automatic speed and tension controls minimize strip breakage and help maintain uniform product quality; 3) side-register control on re-coiler to maintain straight-edge coils; 4) welder control interlocked with line control to minimize welding time. Shown here in left foreground is delivery end of line.

To anneal and galvanize light-gage strip continuously, a large Pennsylvania steel mill recently installed a new galvanizing line complete with G-E drive and G-E electric furnace with protective atmosphere. Worked out co-operatively with Wean Engineering Co., Inc., the co-ordinated G-E drive makes possible these major advantages over former batch methods.

Higher rate of output—Galvanizing a given piece of steel now takes minutes, drastically reducing quantity of material in process.

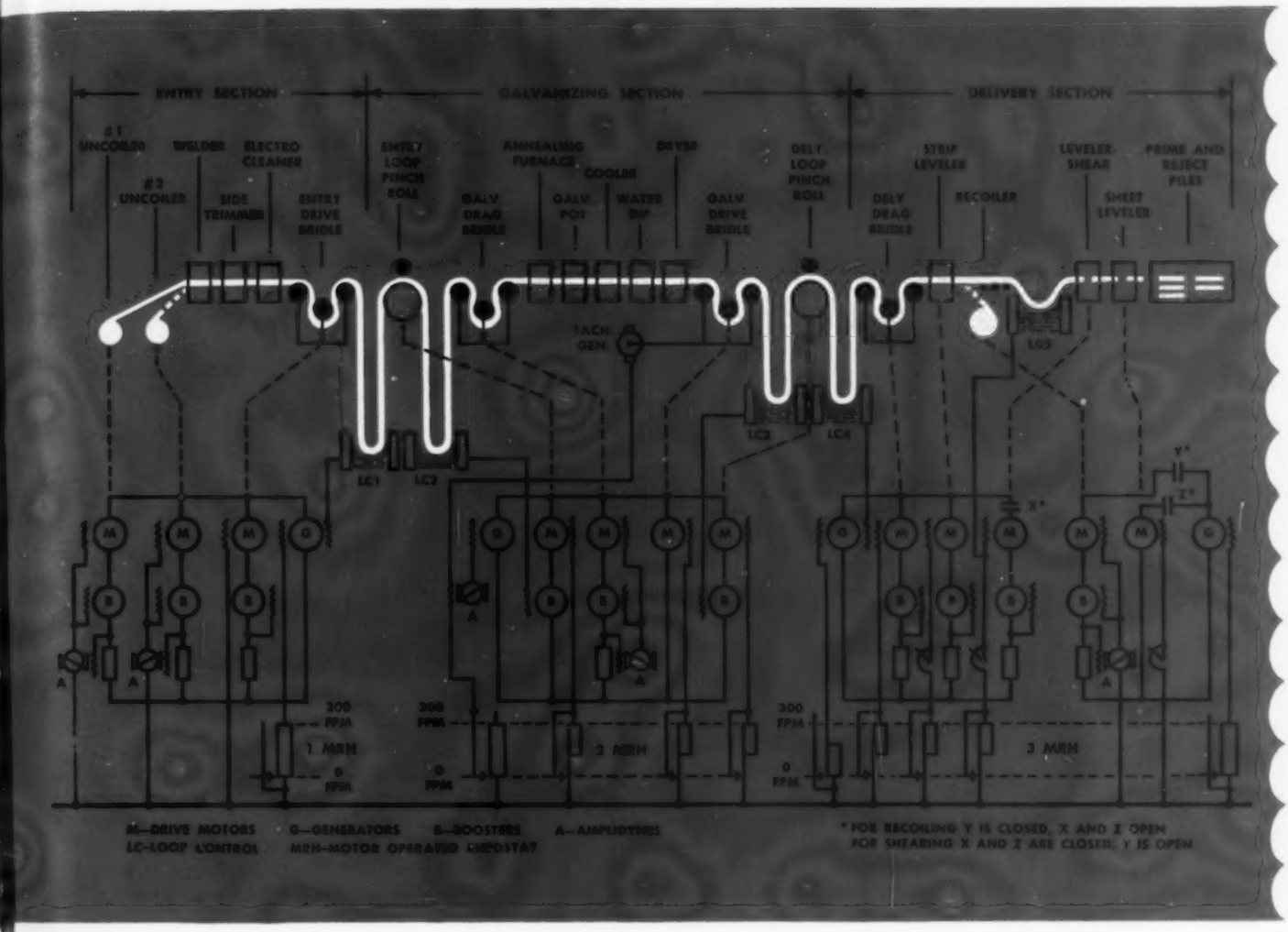
A more uniform product—Corrosion resistance, drawing qualities, zinc adherence, and appearance are all greatly improved.

Lower operating costs—Manpower is freed for other duties, rejects are fewer, fluxing is eliminated, and zinc consumption held to a minimum.

Here is further proof that, for help in meeting *your* needs for higher-speed, more accurately controlled drives, your best bet is to call in a G-E steel-mill specialist—early. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

660-75



HERE'S HOW IT OPERATES

The drive for this continuous galvanizing line is divided into three sections which may be operated independently or in tandem. Amplidyne regulators maintain strip tension through each section and an amplidyne speed regulator holds strip speed constant through the galvanizing section. Looping pits provide strip storage to permit temporary shut-down of the entry section for welding, or of the delivery section for removing coils or stacks, without disturbing the continuous flow of strip through the galvanizing section.

The speed of each section is controlled by a motor-operated rheostat (1MRH, 2MRH, 3MRH). Approximate speed matching between sections is provided by automatic positioning of the motor-operated rheostats, and photoelectric loop controls (LC1, LC4) act on entry and delivery generator auxiliary fields to produce exact speed matching and maintain loop position.

The entry and delivery sections automatically overspeed after a shutdown to restore normal loop positions as quickly as possible. When either end section is shut down, the corresponding loop pinch roll is automatically operated at half of galvanizing section speed, thereby causing both halves of the storage loop to pay out or fill evenly.

This condensed diagram, including only major drives, does not show 13 additional minor drives connected to the adjustable-voltage systems.

another example of
GENERAL ELECTRIC
drive engineering
at work!

Place Refractories FASTER with Lumnite* Refractory Concrete

Pouring Lumnite Refractory Concrete for a slow-cooling pit at Homestead Works of Carnegie-Illinois Steel Corporation's big Munhall, Pa., plant.

YOUR REFRACTORY JOBS get into production in *hours*, instead of days, by using Lumnite Refractory Concrete!

Why? Because simple monolithic construction replaces thousands of small units. Walls aren't laid up. They're poured! Moreover, Lumnite reaches service strength in 24 hours, or less. If needed, repairs and maintenance can be made quickly and easily with a minimum of outage time. For Refractory *Insulating* Concrete, simply change the aggregate, at no extra cost!

Lumnite calcium-aluminate cement has a proved time- and cost-saving record — not only for slow-cooling pits, but for many types of oven and furnace walls, door linings, arches, car tops, floors and base pads; stack linings, flues and foundry floors. In these installations, and many others, it gives consistently better refractory service, under severe thermal shock.

CASTABLES ADD CONVENIENCE. Many prefer to buy prepared castables. These packaged mixtures of Lumnite and selected aggregates are tailor-made to meet your specific temperature and insulation requirements. Add only water. You can buy them from refractory manufacturers and dealers.

For more information about Lumnite, write Lumnite Division, Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, N. Y.

IF RECORDS mean anything, this Lumnite Refractory Concrete slow-cooling pit will still be going strong 5 to 10 years from now even though it absorbs constant battering and thermal shock.

NEED 'EM FAST? By pouring Refractory Concrete, as in this slow-cooling pit, you can save many hours, even days, over other types of refractory construction.

**"LUMNITE"* is the registered trade mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

IS-L-37

ATLAS® LUMNITE for INDUSTRIAL CONCRETES

REFRACTORY, INSULATING, OVERNIGHT, CORROSION-RESISTANT

A UNIVERSAL ATLAS PRODUCT

"THE THEATRE GUILD ON THE AIR"—*Sponsored by U. S. Steel Subsidiaries—Sunday Evenings—NBC Network*

MODERN CABLE DESIGN CAN SAVE YOU MONEY...

But be sure it's been proved too

There have been a lot of new ideas in cable materials and methods over the years—some good, some bad. New ideas often have limitations as well as advantages. The cable which has the *best balance* between the modern and the time-tested, is your best buy.

With Okonite, you can be sure it's modern—and be sure it's *field-proved,* too. For Okonite has constantly maintained the initiative in introducing techniques and materials to the electrical cable industry. Okonite's ultra-modern research facilities are ever abreast of the newest developments, and in 72 years have pioneered countless technological improvements.

But Okonite does not—*will* not—offer a new idea to you until its worth has been proved beyond all question. A new development must survive months . . . and years . . . of every conceivable type of testing before it is built into any Okonite cable.

These are some of the "firsts" which have successfully weathered Okonite's proving ground tests, and the ultimate test of prolonged usage. And, what's more important, these developments have given you cables of greater reliability and wider application to meet the complex and ever-increasing needs of the electrical industry.

FIRST—to introduce rubber-insulated power cable for 35,000-volt service (Okolite)
FIRST—to produce American shock-proof, high voltage rubber-insulated x-ray cables (Okolite)
FIRST—to use neoprene in cable sheathing (Okoprene)
FIRST—to develop (Okoseal) synthetic impervious sheath (PVC) for Navy shipboard cables, now used by the industry in many types of wire
FIRST—to use glass as a wire insulation—quickly adapted by electric motor manufacturers for magnet wire (Okoglass)
FIRST—to introduce high-pressure pipe type cable system for high voltage transmission circuits (Oilostatic)
FIRST—to use semi-conducting tape between conductor and insulation to prevent internal corona-cutting (Semicon Tape)
FIRST—to develop "line-tap" reverse-lay self-supporting aerial cable (Dualay)
FIRST—to introduce all-rubber underground cable (Okosheath)
FIRST—to introduce small diameter building wire to solve problem of rewiring raceways (Okoseal)

When you have a cable problem, ask your Okonite representative to help you choose the most effective cable to meet the job requirement or write directly to The Okonite Company, Passaic, N. J.

THE BEST CABLE IS YOUR BEST POLICY

OKONITE SINCE 1878 *insulated wires and cables*

8638

CRANES . . . FOR THE STEEL MILL

When your Steel Mill Cranes are "Shaw-Box," you have cranes ruggedly built to exacting standards of fine engineering and workmanship that give you reliable, trouble-free performance, dependability with a minimum of attention under the most severe operating conditions.

For many years, the building of steel mill cranes has been an important part of "Shaw-Box" business. Each one traditionally includes the most advanced design and engineering techniques that insure high efficiency, low-operating costs, and exceptional maintenance convenience. Each is an outstanding example of the complete interpretation that can be made of individual mill or AISE specifications, without paying a price premium.

For the greatest value in dependably superior crane performance your purchase dollar can buy, look to "Shaw-Box."

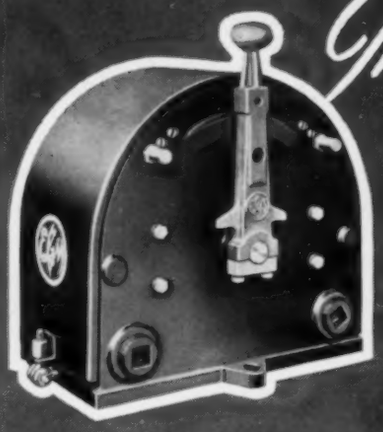
Be sure to send all your inquiries for Steel Mill Cranes and Soaking Pit Carriages to "Shaw-Box."

MANNING, MAXWELL & MOORE, INC.
SHAW-BOX CRANE & HOIST DIVISION
MUSKEGON, MICHIGAN

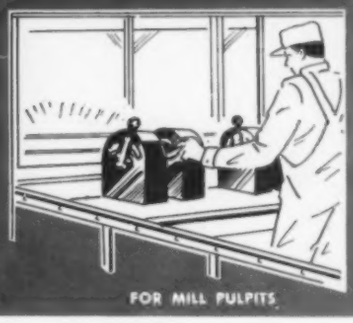
Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load-Lifter' Hoists and other lifting specialties. Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, 'American' Industrial and 'Microsen' Electrical Instruments.

Improved CAM-TYPE SPEED CONTROL MASTER SWITCHES

by E C & M



FOR CRANE CABS



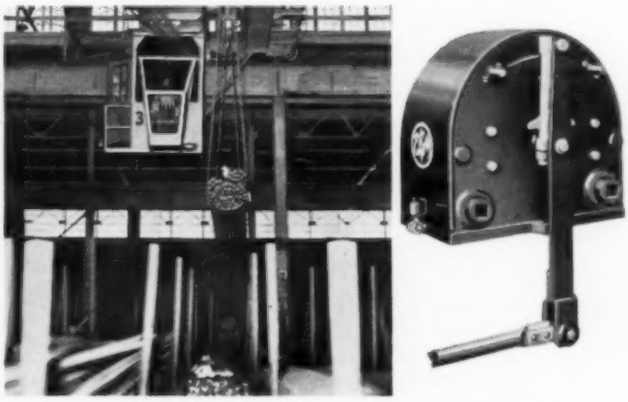
FOR MILL PULPITS

MAKE YOUR OWN COMPACT LAYOUTS with EC&M BULLETIN 1190-A CAM MASTERS

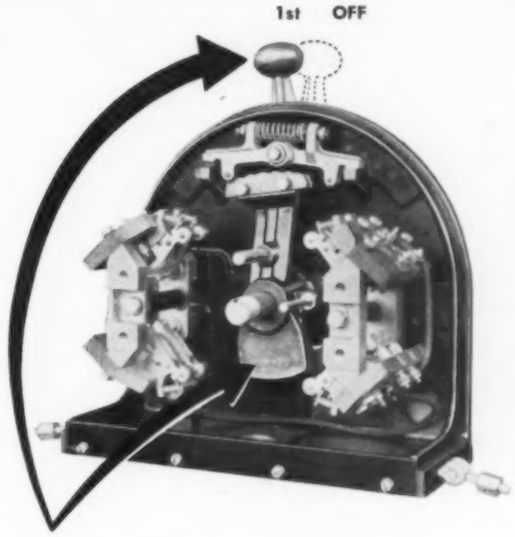
Ever popular with operators, these short-throw, narrow-width Master Switches have recently been improved, thereby increasing this popularity. The speed points are now more distinct without sacrificing ease and smoothness of operation. The views at the right show how this is accomplished.

Also, in many other ways, the EC&M Cam-type speed-control Master Switch is unmatched. Wiring space is generous—positive feed is connected to all common studs—large cams speed opening and closing of coin-silver contacts—overlapping cover excludes dust.

Write for New Bulletin 1190-A



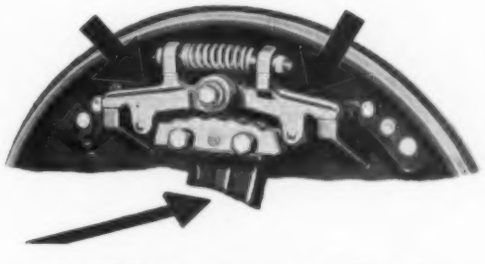
This clear view cab crane is equipped with EC&M under-lever Cam Master Switches which are supplied with extended-arm for attaching under-bar or tube.



Counterweighted aluminum arm eliminates advancing of arm by itself—makes each speed point distinct.

●

Two roller rails with roller pressure adjustable and equalized in both directions of travel make inching easy—either forward or reverse.



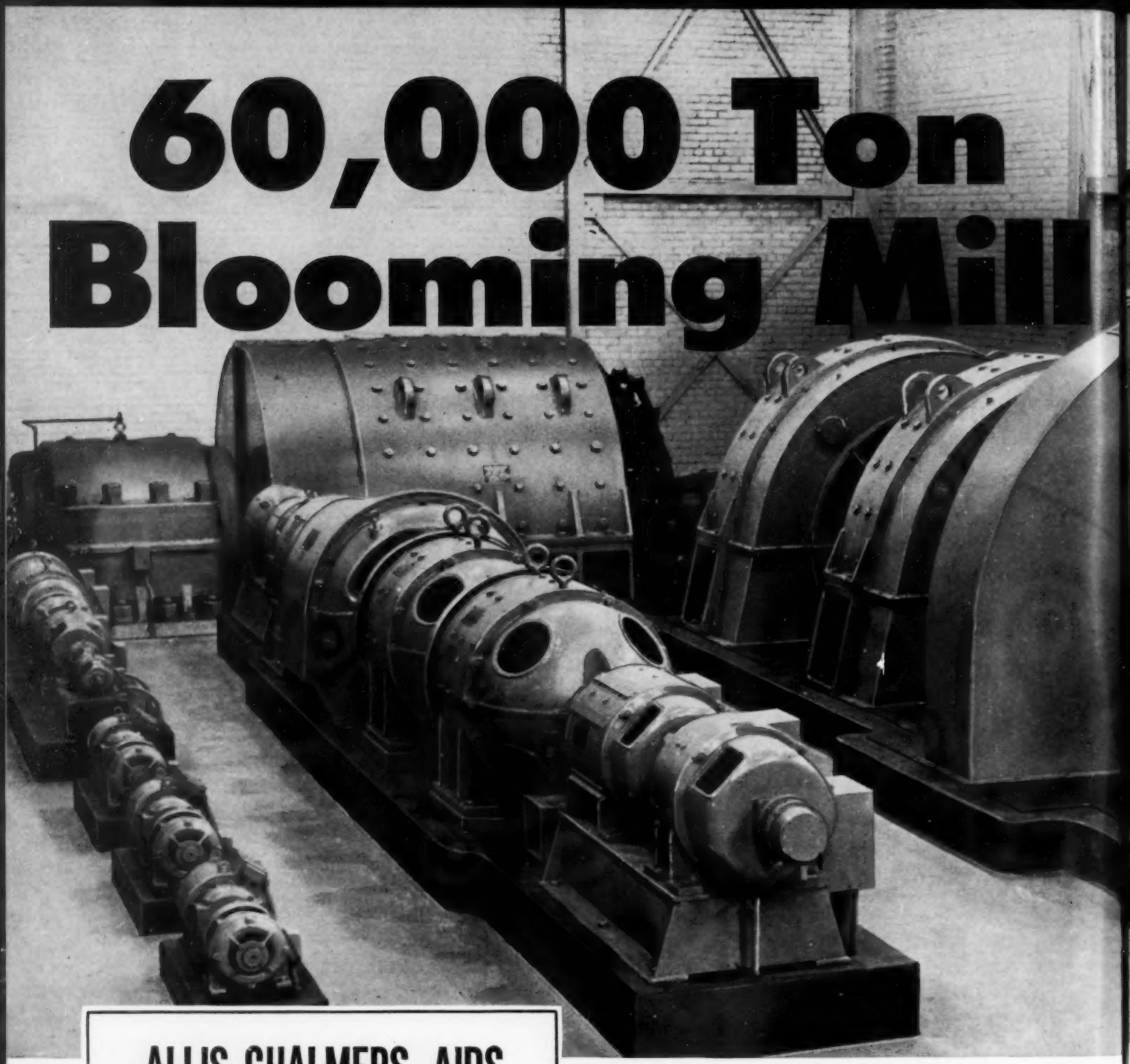
OFF POINT like the neutral position of an automobile gear shift lever.

E C & M

THE ELECTRIC CONTROLLER & MFG. COMPANY

2698 E. 79th STREET CLEVELAND 4, OHIO

60,000 Ton Blooming Mill



ALLIS-CHALMERS AIDS EXPANSION PROGRAM AT ROTARY ELECTRIC STEEL

TODAY THE STEEL INDUSTRY FACES THE TASK of expanding while producing at a record rate. Allis-Chalmers is helping these vital expansion programs, whether they increase output by relieving one restrictive facility or by the revamping or building of an entire plant.

Rotary Electric Steel Co., Detroit, recently completed a $5 million expansion program boosting capacity over two and a half times. Melting and rolling capacity both were increased to serve better the aircraft and automotive industries.

NEW BLOOMING MILL INSTALLED

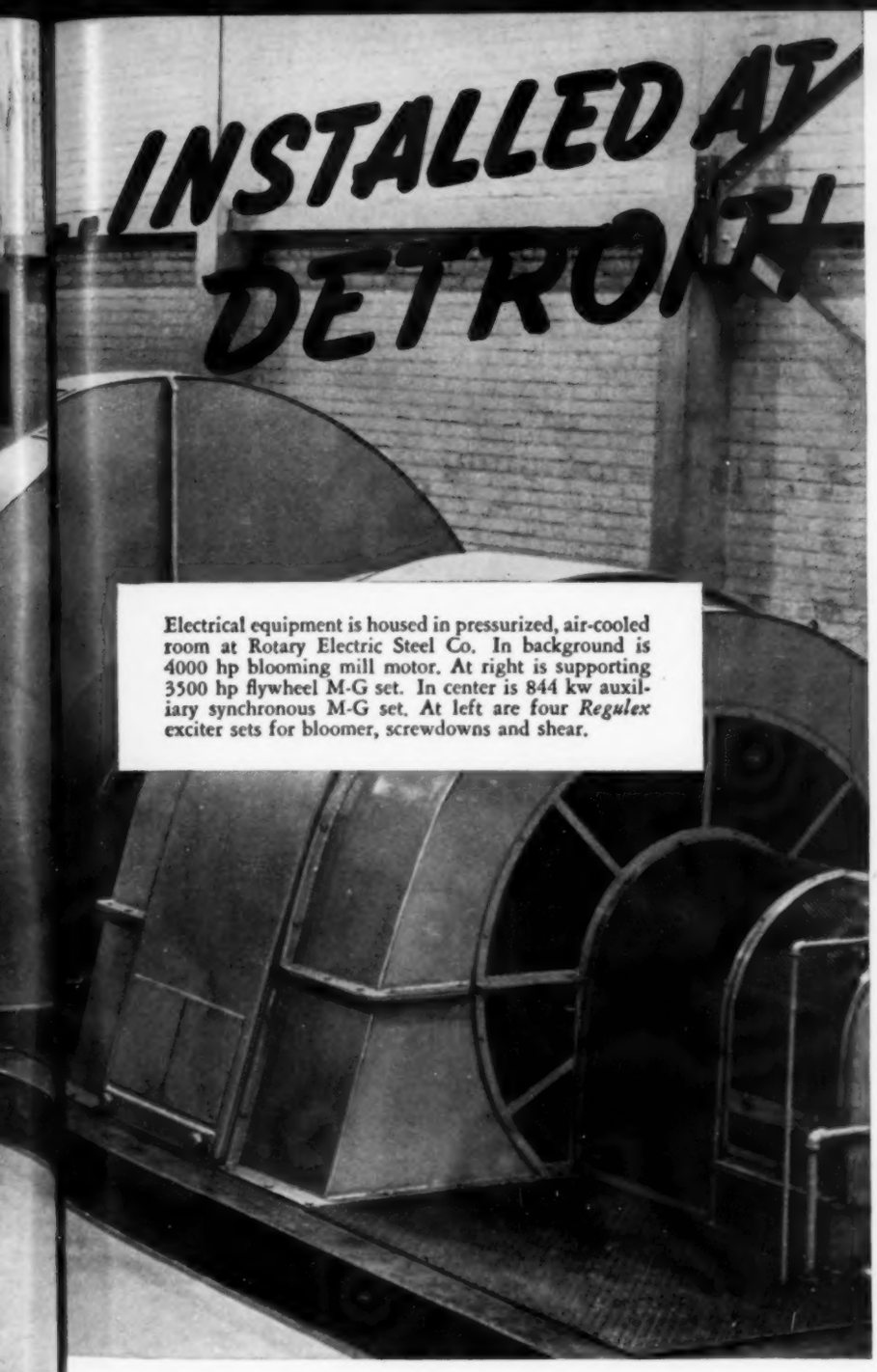
Big item in increasing rolling capacity was the installation of a 36-inch blooming mill, of 60,000 tons per month capacity, replacing the old 28-inch, 12,000 tons per month mill. The 4000 hp blooming mill motor armature is seen at right during construction. The Motor-Generator room view above shows the blooming mill motor, supporting flywheel M-G set, auxiliary synchronous M-G set, and four *Regulex* exciter sets . . . all Allis-Chalmers!

Allis-Chalmers supplied the *complete* electrical equipment

Power, Electrical, Processing Equipment for Iron and Steel

ALLIS-

INSTALLED AT DETROIT



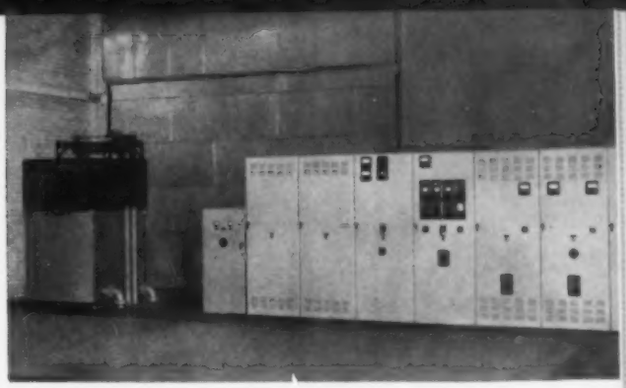
Electrical equipment is housed in pressurized, air-cooled room at Rotary Electric Steel Co. In background is 4000 hp blooming mill motor. At right is supporting 3500 hp flywheel M-G set. In center is 844 kw auxiliary synchronous M-G set. At left are four *Regulex* exciter sets for bloomer, screwdowns and shear.

for this new blooming mill, including switchgear, liquid slip regulator, supporting M-G sets, screwdown and shear drives, and *Regulex* exciter sets. The Sach upcut shear, Allis-Chalmers powered and controlled and first of its design in the U. S., reduces waste by clean cropping. The manipulator, work table and runout table drives and controls also were supplied by Allis-Chalmers.

UNIT RESPONSIBILITY FOR PERFORMANCE

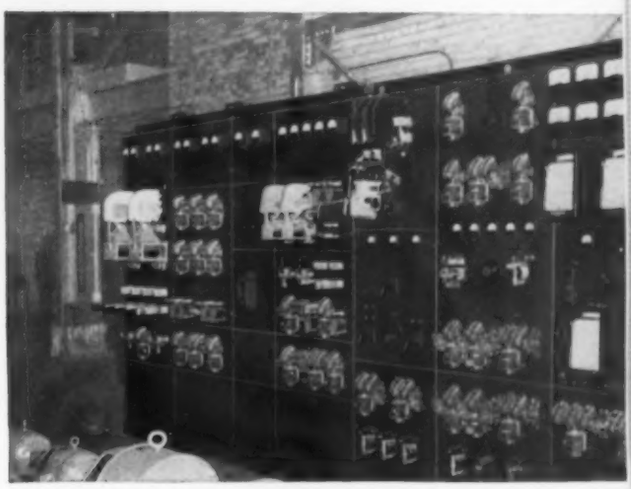
Integrated design of components and one manufacturer responsibility assure you of dependable performance. A qualified steel mill representative will give personal attention to the electrical requirements of *your* plant modernization or expansion. Offices in all major cities. A-3212

ALLIS-CHALMERS, 1020A SO. 70 ST.
MILWAUKEE, WIS.



Allis-Chalmers switchgear controlling 4800 volt, three phase, 60 cycle incoming power. Exclusive 7.5 kv metal clad switchgear with drawout, vertical lift, air blast, 500,000 kva i.c. circuit breakers used here for controlling motor starting and dynamic braking. Control cubicle for liquid rheostat slip regulator at left.

Winding armature in Allis-Chalmers shops for 4000 hp blooming mill dc motor. This motor is supported by the flywheel M-G set at left. A liquid rheostat slip regulator (left, above) enables the 3500 hp flywheel M-G set motor to handle the intermittent heavy loads on the 4000 hp blooming mill reversing motor.

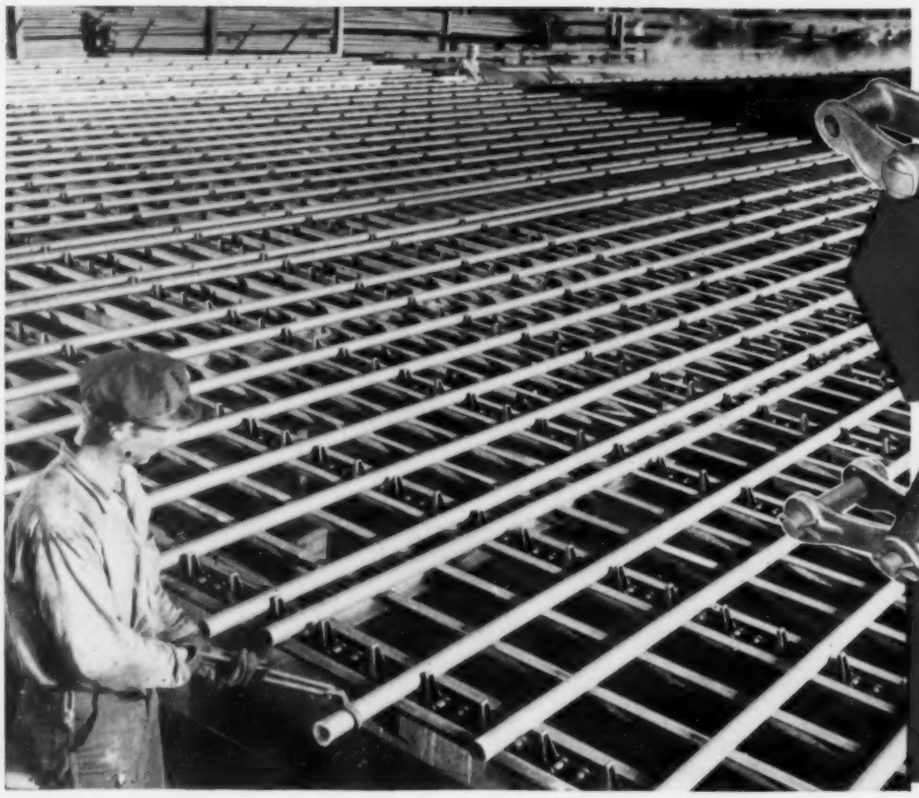


Allis-Chalmers variable voltage control board for 36-inch blooming mill and auxiliaries. From left to right: two panels for new design upcut shear, exciter panel, panel for two 75 hp screwdown motors, three panels for operation of blooming mill main drive.

Regulex is an Allis-Chalmers trademark.

S-CHALMERS

A-C ALLIS-CHALMERS



Steel or pintle chain, in malleable or Promal, (the stronger, longer wearing metal), with pusher attachment as used on pipe cooling rack, as illustrated at left.

Link-Belt "1100" class roller chain, in malleable or Promal, with pusher attachment having replaceable plate for handling larger pipes.

When the Job calls for CHAIN— call for LINK-BELT

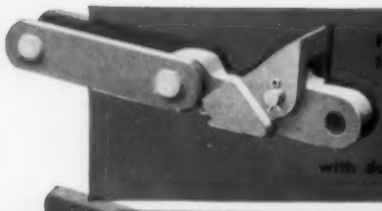
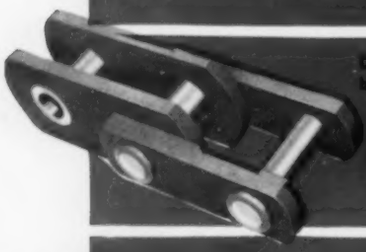
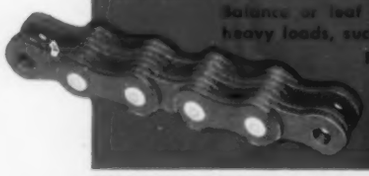


Plate and slat transfer chain for cooling beds; 300,000 lb. chain with tilting dogs illustrated—can be equipped with docking or rigid dogs.



Draw-Bench chain, bushed ladder type, for high speeds and elimination of chatter. Also furnished in conventional block type.

SS-388 chain, for roller-and-catcher tables, light and strong for the exceptionally tough service of this application.



Balance or leaf chain, for supporting heavy loads, such as billets at forging presses.

Link-Belt Precision steel roller chain, for power transmission, also widely used for conveying, with or without various attachments.

Link-Belt chains are built to take the brutal punishment of steel mill service, dependably, turn after turn, year after year. For particularly grueling tasks, there are specially developed Link-Belt chains, and throughout the mill, standard types for the basic elements of complete handling systems.

There's a Link-Belt chain for every spot, and Link-Belt is the spot to go for every chain.

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Johannesburg. Offices, Factory Branch Stores and Distributors in Principal Cities. 11,977

LINK-BELT

Chains and Sprockets

An Orchid to a Champion

45" Reversing Slabbing Mill which has broken all world records by rolling 169,338 net slab tons in one month.

designed and built by

United

ENGINEERING AND FOUNDRY COMPANY

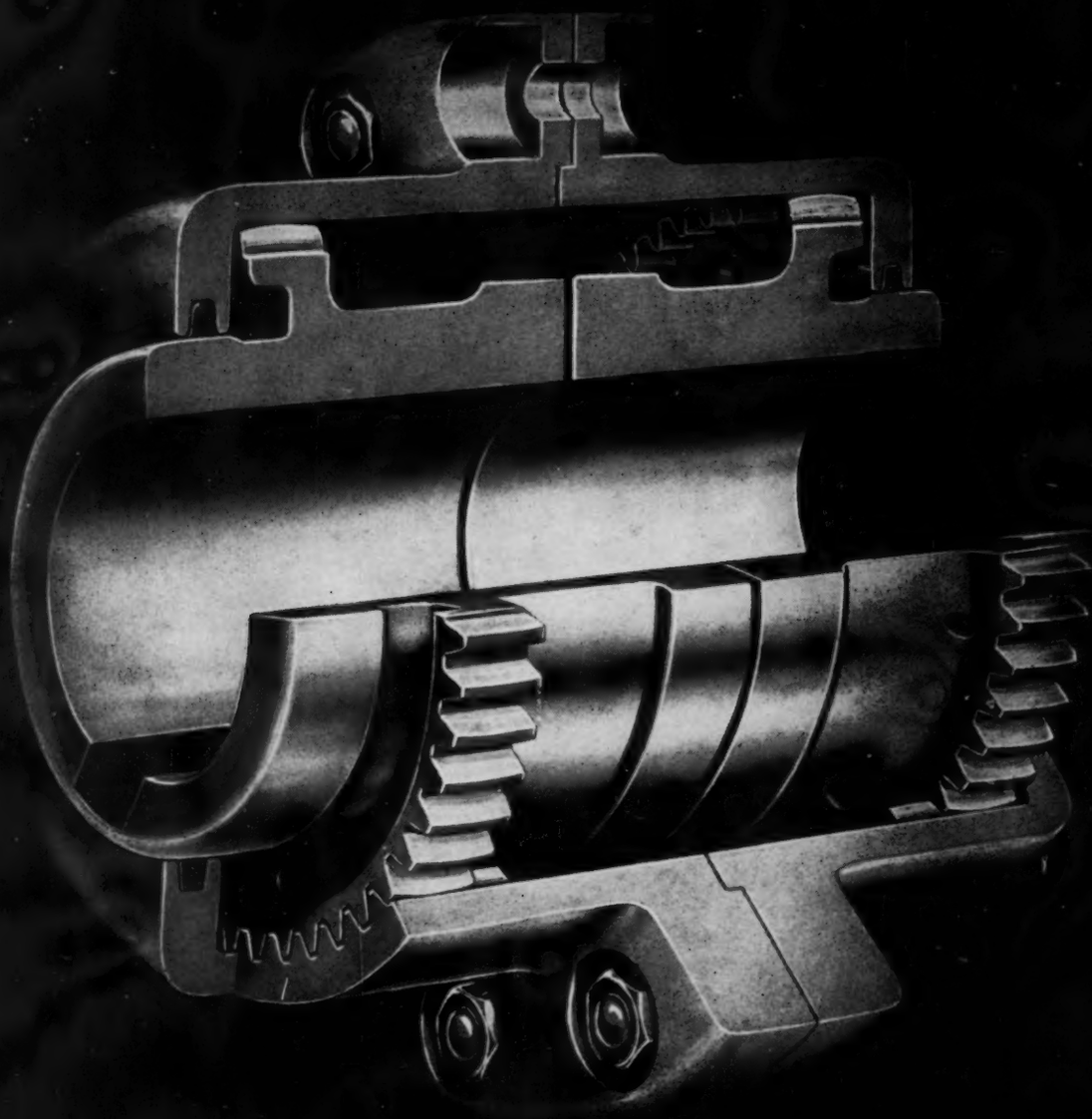
Pittsburgh, Pennsylvania

PLANTS AT PITTSBURGH • VANDERGRIFT • NEW CASTLE
YOUNGSTOWN • CANTON

SUBSIDIARIES: ADAMSON UNITED COMPANY, AKRON, OHIO
LOBDELL UNITED COMPANY, WILMINGTON, DELAWARE
STEDMAN FOUNDRY AND MACHINE CO., INC., AURORA, INDIANA

Designers and Builders of Ferrous and Non-Ferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other heavy machinery. Manufacturers of Iron, Nodular Iron and Steel Castings and Weldments.

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

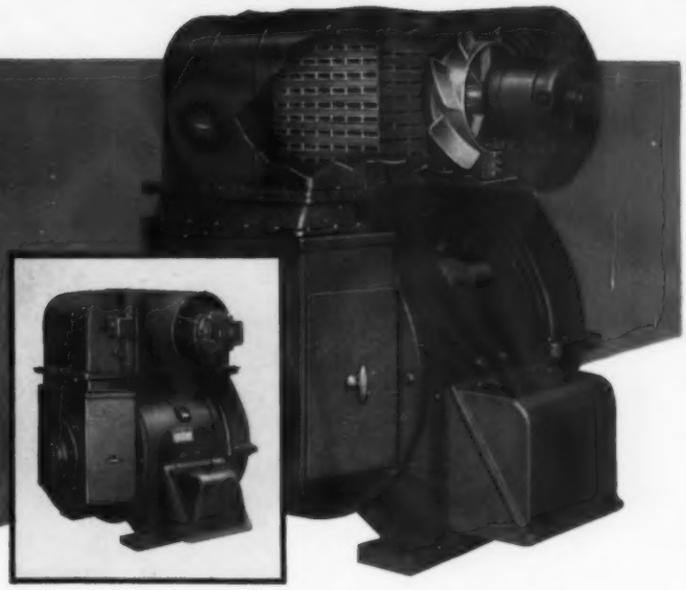
FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

REDUCE PRODUCTION STOPPAGES

due to harmful atmospheres



UNIT-COOLED

D-C MOTORS

from 15 to 200 hp

Single-blower type for normal speed operation In this standard G-E motor, the unit cooler consists of alternate air passages placed at right angles to each other. Clean motor air, kept in motion by a fan on the main motor shaft, circulates through one set of passages in an enclosed system. Cool outside air, drawn into the cooler by a blower separately motor-driven, flows through another set of passages and absorbs the heat from the internal air stream. Motor air, never in contact with contaminated outside air, is always clean.

Reliable Performance . . . dust, dirt, dampness, metal particles, or oily vapors can't affect the operation of these General Electric standard, totally-enclosed, unit-cooled d-c motors.

Fewer Inspection Shutdowns . . . windings, brushes, and brush rigging are kept clean at all times because motor air never comes in contact with contaminated outside air.

Reduce Power Cost . . . because motor heat is rapidly dissipated, power consumption is less, especially in wide-range adjustable-speed motors.

Simplify Maintenance . . . large openings in the commutator end shield make it easy to get at commutator, brushes, and brush rigging.

Save Mounting Time . . . interchange of motors to meet changing plant conditions takes less time because G-E totally-enclosed motors have the same mounting dimensions as G-E open motors of the same ratings.

Get The Whole Story . . . ask your G-E representative how these sturdy, protected motors can increase production and trim operating costs in your plant, or send for Bulletin GEA-4469. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

Double-blower type for continuous low speeds New—a totally enclosed standard G-E motor that can't run a fever! Without danger of overheating, it delivers full torque continuously, even at very low speeds. Key to its operation is a new development—ventilation entirely independent of motor speed. Two blowers, mounted on opposite shaft extensions of a single auxiliary motor running at constant speed, provide full ventilation at all times. One circulates internal air and the other external air through alternate vertical passages.

GENERAL ELECTRIC

770-23

DUST and DIRT are out of date

Tandem cold strip mill at Weirton

Today's Best Buy is Better Air!

AAF *Electro*-MATIC Filters provide super-clean air to keep motors running steadily

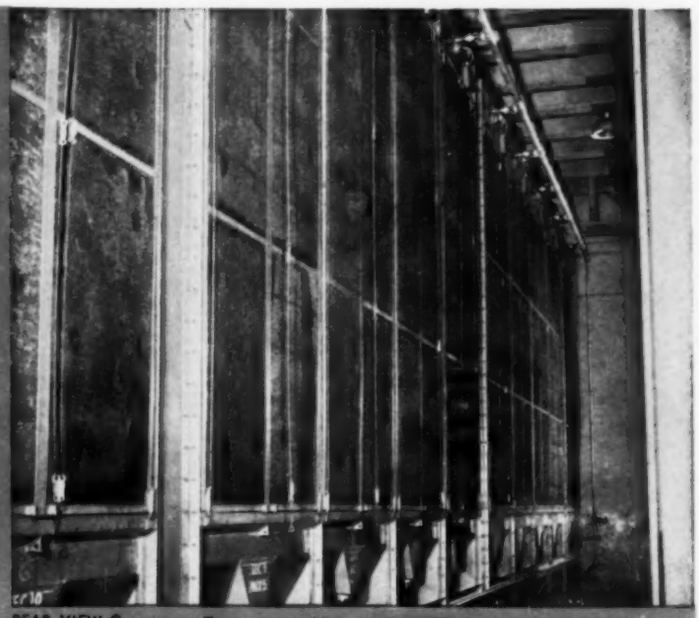
Today, with demand for steel at record high, steelmakers are taking every opportunity to keep production rolling, and protect costly equipment against breakdowns.

Continuous, uninterrupted production depends largely on main drive motors. Their protection against the hazardous dust in steel mills is an essential requirement for continuous operation.

Both in new mills and the modernization of existing plants, super-clean air is considered a must for mill motor ventilation.

A typical example toward more efficient air cleaning is the wide use of ELECTRO-MATIC* Precipitators in the modernization program of Weirton Steel Company. Their overall plan will involve more than a million and one half cfm in twelve different installations. Installation of the ELECTRO-MATIC shown in the electrolytic tin mill—the country's most modern and highest speed mill of its type. This filter provides super-clean air for the ventilation of drive-motors, rectifier tubes and other electrical equipment.

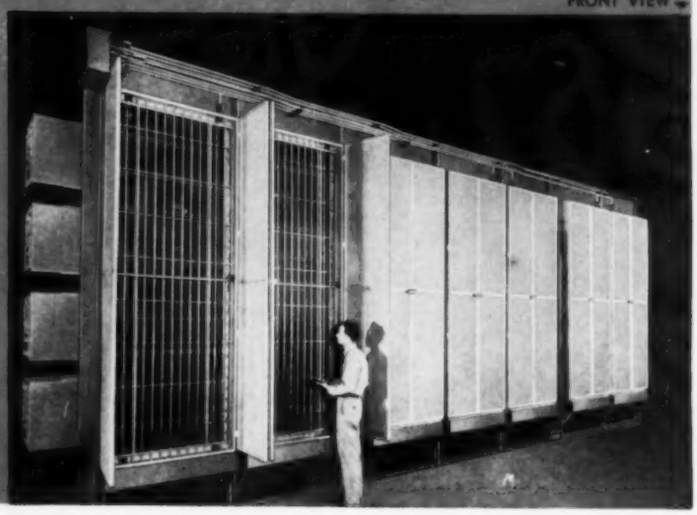
when steel mills modernize!



REAR VIEW ▲

ELECTRO-MATIC installation at Weirton electrolytic tin mill.

FRONT VIEW ▼



HERE ARE THE REASONS WHY THE

AAF *Electro*-MATIC

IS PREFERRED IN STEEL MILLS:

- **HIGHEST CLEANING EFFICIENCY** over a wide range of particle sizes, from smoke to largest airborne material.
- **CONTINUOUS OPERATION** made possible by the self-cleaning action which eliminates interruptions and shut-downs necessary with manual maintenance.
- **UNIFORM HIGH EFFICIENCY** since collector plates are maintained at peak efficiency by continuous cleaning.
- **CONSTANT AIR VOLUME** due to the spacing of the collector plates which makes the filter curtain non-clogging.
- **ABSOLUTE SAFETY** as the entire casing and exposed parts of the filter are electrically grounded.
- **LOW CURRENT CONSUMPTION**—the power required for the electrostatic action averages about 15 watts per 1,000 cfm. The current consumed by each drive motor is negligible—about 2 K.W. per month.
- **EASILY INSTALLED,** filter is built in standardized self-contained sections, and require no special duct construction.

WRITE FOR AAF's ELECTRO-MATIC BULLETIN #250

In order to make this filter installation fully automatic, the Viscosine is continuously circulated through clarifiers which eliminate infrequent removal of the collected sludge.

AAF's ELECTRO-MATIC offers advantages not found in any other precipitator. The self-cleaning action not only minimizes maintenance but maintains collector plates at peak efficiency at all times.

* *Automatic electronic precipitator.*

AAF

American Air Filter

COMPANY, INC.

302 Central Avenue, Louisville 8, Kentucky • In Canada: Darling Bros., Ltd., Montreal, P. Q.

U. S. Pat. 2,181,076

SPEER carbon brushes, with their freedom from sparking, overheating, and energy loss, are widely used in the electric motors that gather and pump oil. The high current-carrying capacities and excellent contact provided by Speer brushes make them equally valuable in motors for *any* pumping job.

A complete line of brushes has been developed by Speer to match every mechanical and electrical service characteristic. All have been rigidly tested under actual service conditions. For smooth, trouble-free commutation . . . for peak motor performance . . . fit your motors with Speer carbon brushes.

Speer

CARBON COMPANY
ST. MARYS, PENNA.

brushes · contacts · welding electrodes · graphite anodes · rheostat discs · packing rings · carbon parts

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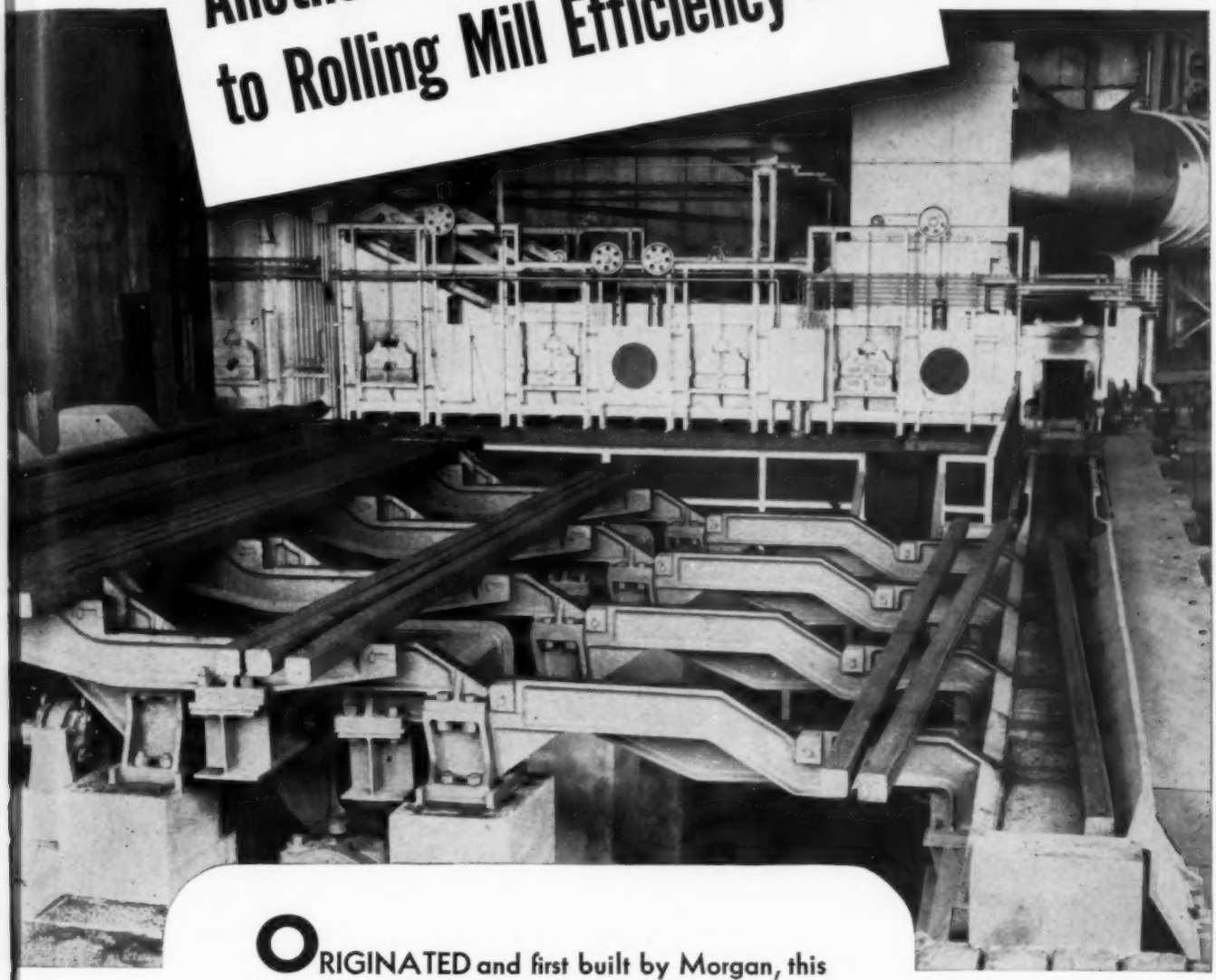
Another Morgan Contribution to Rolling Mill Efficiency . . .



ORIGINATED and first built by Morgan, this billet "unscrambler" is one of the interesting innovations in the Colorado Fuel and Iron Corporation's new Morgan 3-strand rod mill at Pueblo, Colorado.

These billet and slab separating skids—with the furnace charging conveyor, the ram type charger and furnace cross pusher—are operated in complete safety by one man. For the current high tonnage demands, these mechanical skids can handle billets and slabs at rates up to 200 tons per hour.

If you have a rolling mill problem that needs "unscrambling" why not discuss it with our engineers?

MORGAN CONSTRUCTION CO.

WORCESTER, MASSACHUSETTS

English Rep., International Construction Co., 56 Kingsway, London W. C. 2, Eng.

RM-33

MORGAN
WORCESTER

ROLLING MILLS • MORGOIL BEARINGS
WIRE MILLS - GAS PRODUCERS - AIR EJECTORS
REGENERATIVE FURNACE CONTROL

get these

3 BIG ADVANTAGES

by using

"BIRDSBORO 40"

COPPER ALLOY STEEL ROLLS

1. ***RAPID HEAT-DISSIPATION*** —Reduces fire cracking to the minimum; means less wear—longer life before scrapping.
2. ***GREATER ENDURANCE***—Ability to withstand higher mechanical and thermal shocks due to sudden temperature change such as encountered when going from wet to dry or dry to wet rolling.
3. ***TIGHTER SURFACE GRAIN***—Holds mirror finish longer; improves quality of rolled surfaces.

Added together, they mean that you can roll alloy, stainless and high speed steels in greater volume at lower cost per ton. To get full details on how "BIRDSBORO 40" rolls can help solve your production problems, get in touch with our roll engineers.

BIRDSBORO ROLLS

BIRDSBORO

STEEL FOUNDRY & MACHINE CO.

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Offices in:

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ROLLS

Designers and Builders of:

Rolls • Crushing Machinery • Steel Mill Machinery

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R-2-50

3 Production Benefits from this Remarkable Instrument

1. Closer Combustion Control
2. Better Quality Control
3. Productivity Raised

The Cities Service Heat Prover Analyzes Combustion Atmospheres of Industrial Furnaces

Regardless of type or size of furnace, atmospheres vital to steel production are quickly, accurately and completely analyzed. With this one remarkable instrument it is easy to determine how much fuel is wasted, whether excess oxygen may be present to cause scaling and how much energy is wasted in uselessly heating excess air.

A complete line of petroleum products for the Metal Fabricating Industry including:

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Operating records prove

Matched properties make VEGA BOND the ideal bonding material for VEGA refractories

VEGA BOND is a super-duty silica cement developed primarily for use with VEGA brick, particularly where conditions are unusually severe. It is highly plastic, smooth working, spreads evenly and develops a firm ceramic set at working temperatures. Vega Bond is the close counterpart of Vega Brick in composition and in the properties of refractoriness and thermal expansion.

It does not shrink to make a joint that recedes, nor expand beyond the silica brick and thus make a loose joint. It makes a thin, full-contact joint, but can be mixed to a thicker consistency if required for leveling courses.

that VEGA makes possible increased production...reduces costs

Experience with Harbison-Walker VEGA demonstrates that this super-duty silica brick has a longer life and permits higher operating temperatures, thus increasing tonnage output and reducing costs. Where conditions are most severe, the advantages provided by VEGA brick are most apparent.

Open hearth roof life has been extended 20-30% when Vega has been used in place of conventional silica brick; electric furnace sidewall life has been doubled. Higher temperatures can be maintained in furnaces built with Vega—or longer runs made at regular temperatures. In any case, the net result is greater production and reduced costs.

In the original development of Vega Brick, many years of thorough laboratory research were coupled with trials made under severe operating conditions to work out the product that is now rendering outstanding service in steel-making furnaces.

For open hearth roofs and electric furnace roofs and sidewalls, Vega—the Harbison-Walker super-duty silica refractory—can make new records for you!

the Harbison-Walker super-duty silica brick

Harbison-Walker Refractories Company
AND SUBSIDIARIES

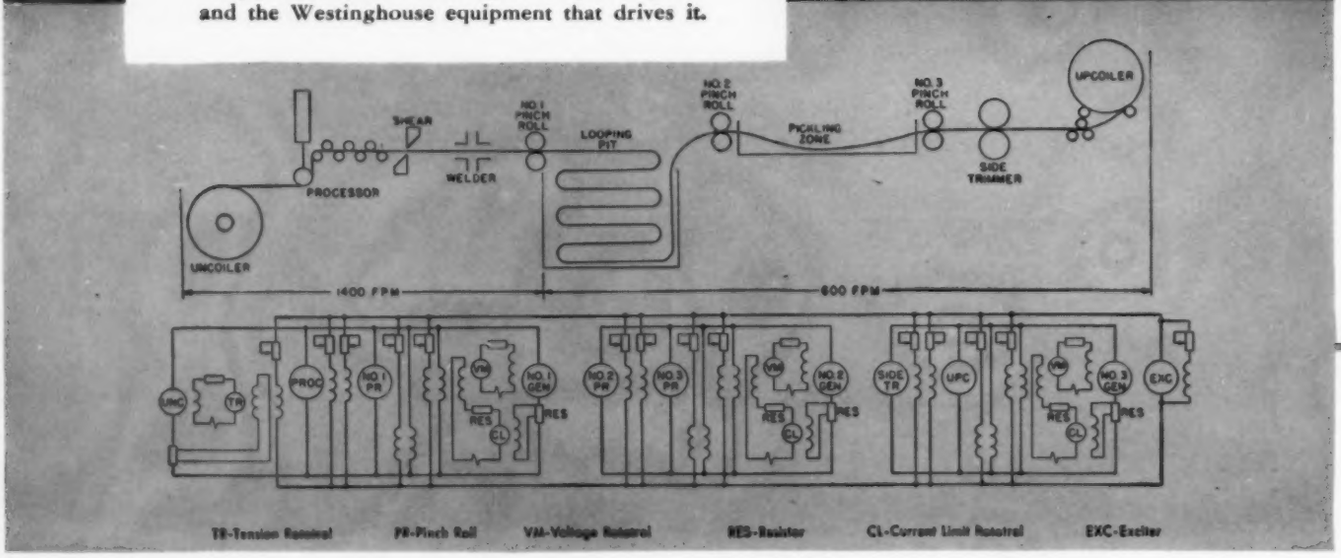
WORLD'S LARGEST PRODUCER OF REFRACTORIES
General Offices . . . Pittsburgh 22, Pennsylvania

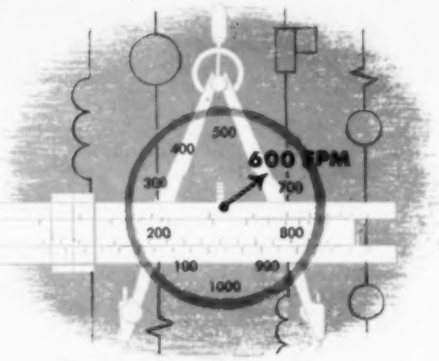
YOU CAN BE **SURE**.. IF IT'S
Westinghouse

Looping pit in the world's fastest strip pickling line, and shown beyond it, the pickling tanks.

• • •

Simplified schematic drawing of the pickling line and the Westinghouse equipment that drives it.





The world's fastest strip pickler

CAN YOUR NEXT JOB USE THE KNOW-HOW THAT ENGINEERED ITS ELECTRIC DRIVE?

You may not be considering strip pickling lines right now. But the know-how that engineered the drive for this one *can* make your next installation a better one, whatever it may be. Here's how it met this problem.

The mill wanted a line to turn out 50,000 tons per month in 30,000-lb. coils. That meant an exit speed around 600 fpm, *20% faster than any other line in existence.* Four or five hot-rolled coils would be fed in for each emerging coil. So to allow for time required in shearing, welding, and trimming the ends, the entry speed had to be 1400 fpm.

So these were the basic requirements: 1. Build a drive that keeps speed *constant* in the pickling zone to keep quality uniform. 2. Maintain constant rates of *acceleration and deceleration* in the entry side so that a high-production, continuous operating cycle could be established. 3. Provide *fast* acceleration and deceleration to minimize idle time at the entry end.

Westinghouse answered the needs with a three-stage adjustable-voltage drive regulated by ROTOTROL, the master electrical intelligence. The first-stage motors, supplied by one M-G set, drive the uncoiler, scale-breaker, shear, welder, trimmer, and pinch roll—the strip passing through each in turn. Strip then enters the looping pit. The second-stage motors, supplied by a second M-G set, drive the pinch rolls on either side of the pickle tank. The third stage drives the exit end of the line: a second shear, side trimmer, oiling rolls and final coiler.

The three-stage drive gives the needed speed differential AND speed control. Moreover the line is easy to operate since all operations, including shearing, welding, and trimming are at least semiautomatic.

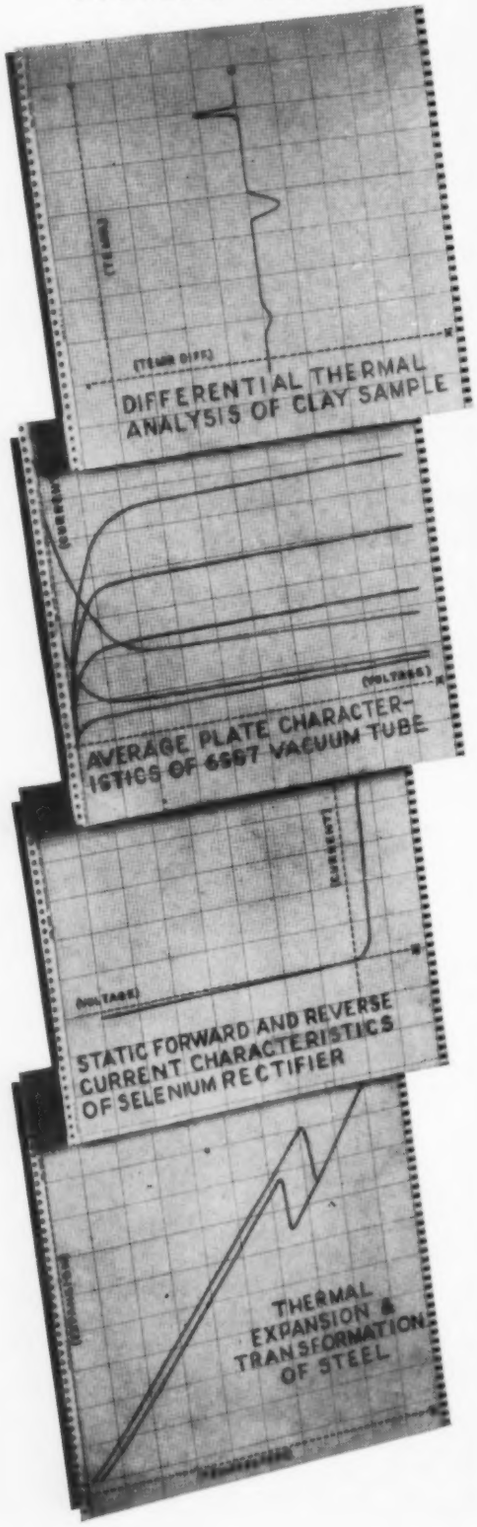
It took the combined efforts of the mill, the equipment builders and Westinghouse to engineer this line. The electric drive is a result of this company's lifetime of intimate contact with the steel industry. And it can pay off on your next job. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-94845

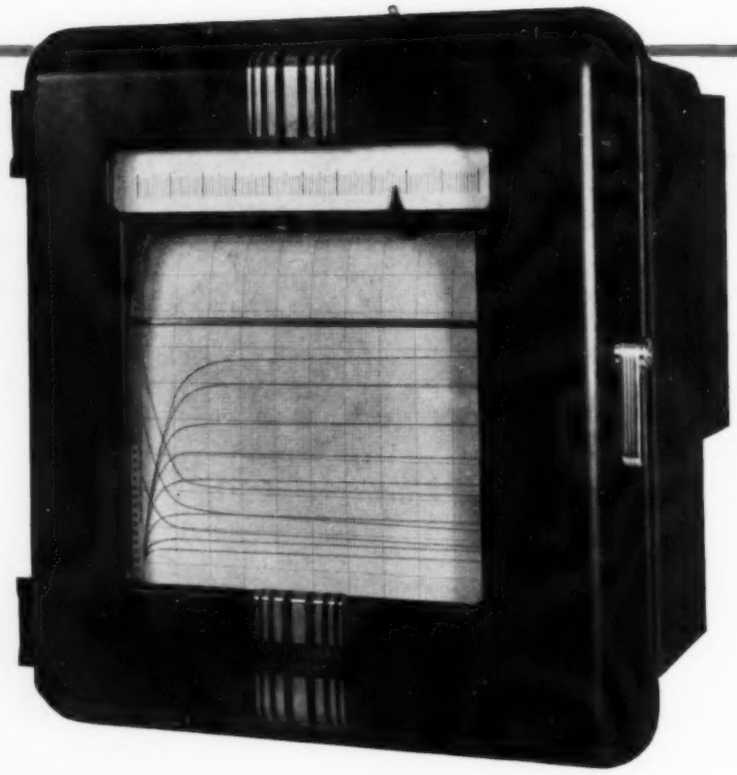
Westinghouse

EQUIPMENT FOR THE STEEL INDUSTRY

Now you can plot X vs. Y...automatically

TYPICAL CURVES


DIFFERENTIAL THERMAL ANALYSIS OF CLAY SAMPLE
AVERAGE PLATE CHARACTERISTICS OF 6SS7 VACUUM TUBE
STATIC FORWARD AND REVERSE CURRENT CHARACTERISTICS OF SELENIUM RECTIFIER
THERMAL EXPANSION & TRANSFORMATION OF STEEL



with the

New Speedomax 2-Function Recorder

Boon to engineering and research laboratories, this new Speedomax Recorder automatically plots a continuous, accurate curve showing the relationship between any two variables brought to the instrument in the form of d-c signals. Gone are those hours of tedious compilation and point-by-point plotting of data.

Just glance at these typical curves and note the instrument's remarkable versatility. Its big 10" chart provides remarkably complete detail. Potential applications are as broad as a researcher's imagination.

This new X-Y Recorder has *two* electronic circuits, one for each function. X corresponds to horizontal pen travel; Y to up-and-down movement of the chart. Input voltage can be as low as 2.5 mv for X; 10 mv for Y. Response time is amply fast—just 2 sec for full scale pen travel (X); 4 sec per 10" of chart (Y).

For details, send for Folder EM9-420(1). Write us at 4942 Stenton Ave., Philadelphia 44, Pa.

Jrl Ad EM9-420(2)

MEASURING INSTRUMENTS TELEMETERS AUTOMATIC CONTROLS HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

...Your best buy

Power cable installations consist of material —

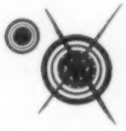
cable *conduit* *fittings* *lugs* *—*

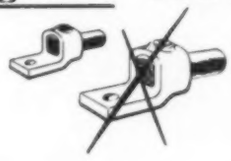
PLUS installation time

The MANHOURS *required per installation*

are proportional to the weight *of materials used.*

*ROCKBESTOS A.V.C.® carries more current.**

Therefore you can use smaller— lighter cable 

conduit *fittings* *lugs* 

The total weight *to lift, hang, pull, is*

cut 1/3 *and installation MANHOURS*

are materially reduced.

Q.E.D. ROCKBESTOS A.V.C. SAVES MANHOUR $

*National Electric Code— Chapter 10

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Chicago • Detroit • Pittsburgh • St. Louis • New Orleans

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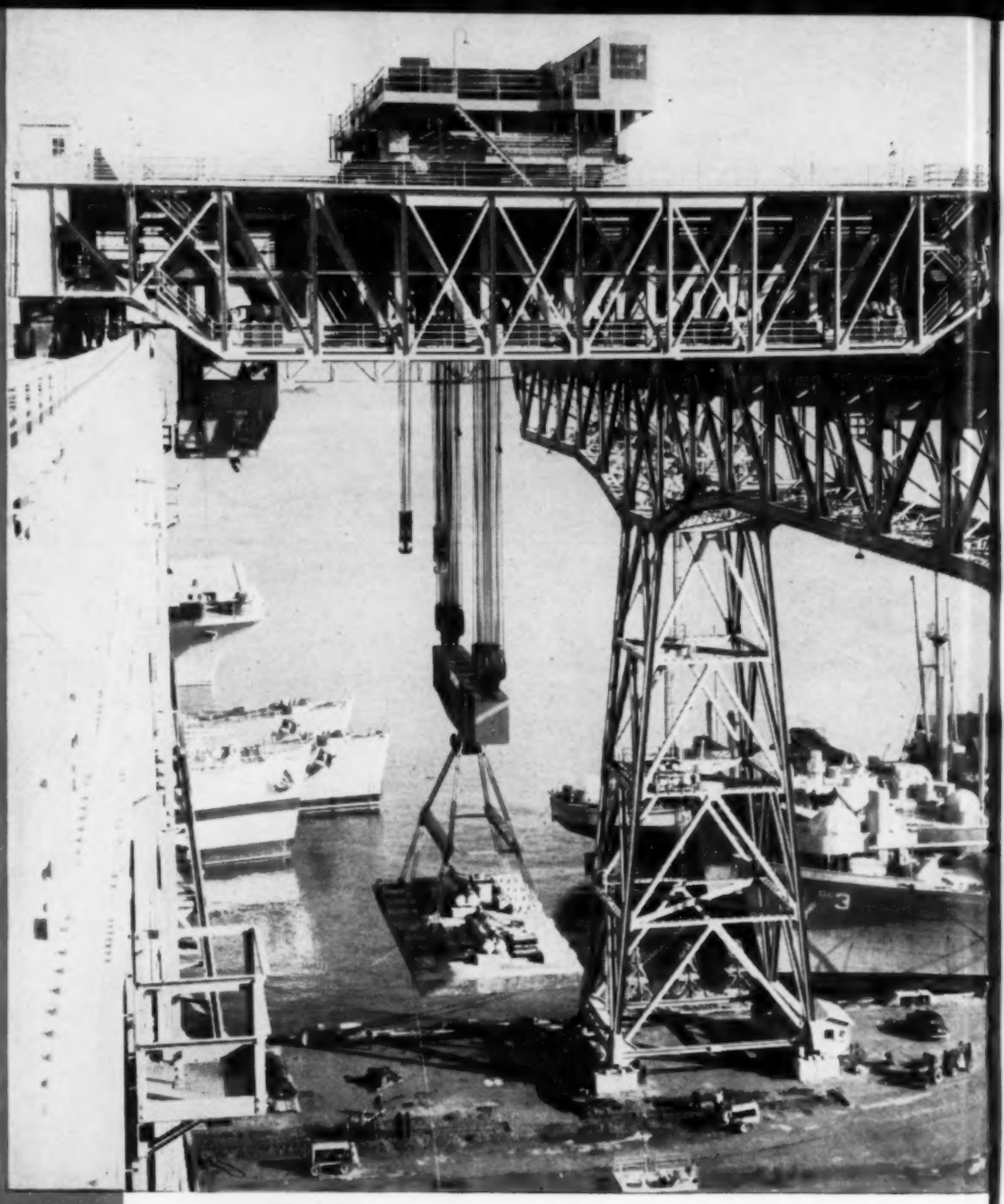
1ST

IN STRENGTH

1ST

IN SIZE

IT'S



Alliance ...

THE LARGEST CRANE IN THE WORLD!

Talk about giants—you should see this huge Alliance crane spanning the Navy's mole at Hunter's Point, California. It's the world's largest crane, and is so big and powerful that it can easily pick up a 500-ton battleship gun turret!

This rugged crane with the amazing precision control is so large that it has its own electric sub-station, aerial beacons to warn aircraft away, and a short-wave radio for communication between the operating crews. The bridge span of the crane is 142 feet center to center of rails, and the span of the trolley is 20 feet. Its two cantilevers extend 162½ feet out over the water on each side of its specially-built pier.

Of course, Alliance builds smaller cranes, too . . . all sizes, in fact, to help move heavy loads quickly, safely, and easily.

Always depend on Alliance to give your plant the economical, extra lifting power you need.

- LADLE CRANES
- GANTRY CRANES
- STRIPPER CRANES
- SOAKING PIT CRANES
- FORGING MANIPULATORS
- OPEN HEARTH CHARGING MACHINES
- SLAB AND BILLET CHARGING MACHINES
- SPECIAL MILL MACHINERY
- STRUCTURAL FABRICATION

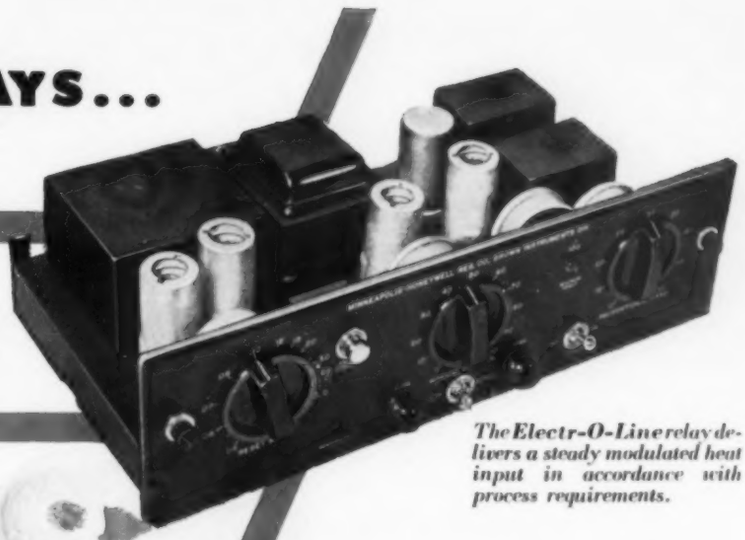
THE ALLIANCE MACHINE CO.

Main Office
ALLIANCE, OHIO

Pittsburgh Office
1022 OLIVER BLDG., PITTSBURGH, PA.

NEW CONTROL RELAYS...

Electr-O-Line



The Electr-O-Line relay delivers a steady modulated heat input in accordance with process requirements.

Electr-O-Pulse

The Electr-O-Pulse relay delivers a modulated full heat input on a pulse-time basis in accordance with process requirements.

FOR YOUR FURNACE
FOR YOUR PRODUCT

For EXACTING CONTROL of INDUSTRIAL FURNACES, Brown offers two new relays: the *Electr-O-Line* for position proportioning control and the *Electr-O-Pulse* for time proportioning control. Completely electronic and both providing automatic reset, these units are designed as an integral part of Brown Proportional Controllers or as separate models for modernizing existing installations. Outstanding features include:

- *Control adjustments are completely independent making "tuning in" process very simple.*
- *Manual control of the process may be accomplished from the relay.*
- *Plug-in type chassis simplifies servicing and wiring.*
- *Both the Electr-O-Line and Electr-O-Pulse relays are physically interchangeable with the Brown Manual Reset relay when used with Brown ElectroniK Proportional Controllers.*
- *Designs are electronic and have no motor driven resistors.*

Brown Instruments, the most *complete* modern line of controllers, include the *right* control for your furnace . . . for your product. There need be no compromise on a control job . . . no need to "stretch" the application to fit the instrument. Your local Honeywell engineer can impartially advise you on the *correct type of instrument* for your requirements. Call him today . . . he is as near as your phone!

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4464 Wayne Ave., Philadelphia 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

low costs ahead

with P&H ELECTRIC SHOVELS

Better shovels mean better production in every way. And here's another team of P&H Electrics that are proving it. They're faster, of course. P&H Magnetorque* Hoist gives you smoother, livelier dipper action with electro-magnetic power. There's no friction, no wear.

You'll find some other important differences in P&H design . . . including the husky all-welded construction that gives you greater strength to withstand shock loads—and the increased electrical efficiency that gives kilowatts a new incentive. They all add up to the steady, dependable operation that lets you maintain schedules and cut tonnage costs for years to come.

On a major investment of this kind, you should *know* how much more P&H Electric Shovels give you. Ask for the facts. Write today!

*Trade-mark of Harnischfeger Corporation for electro-magnetic type clutch.

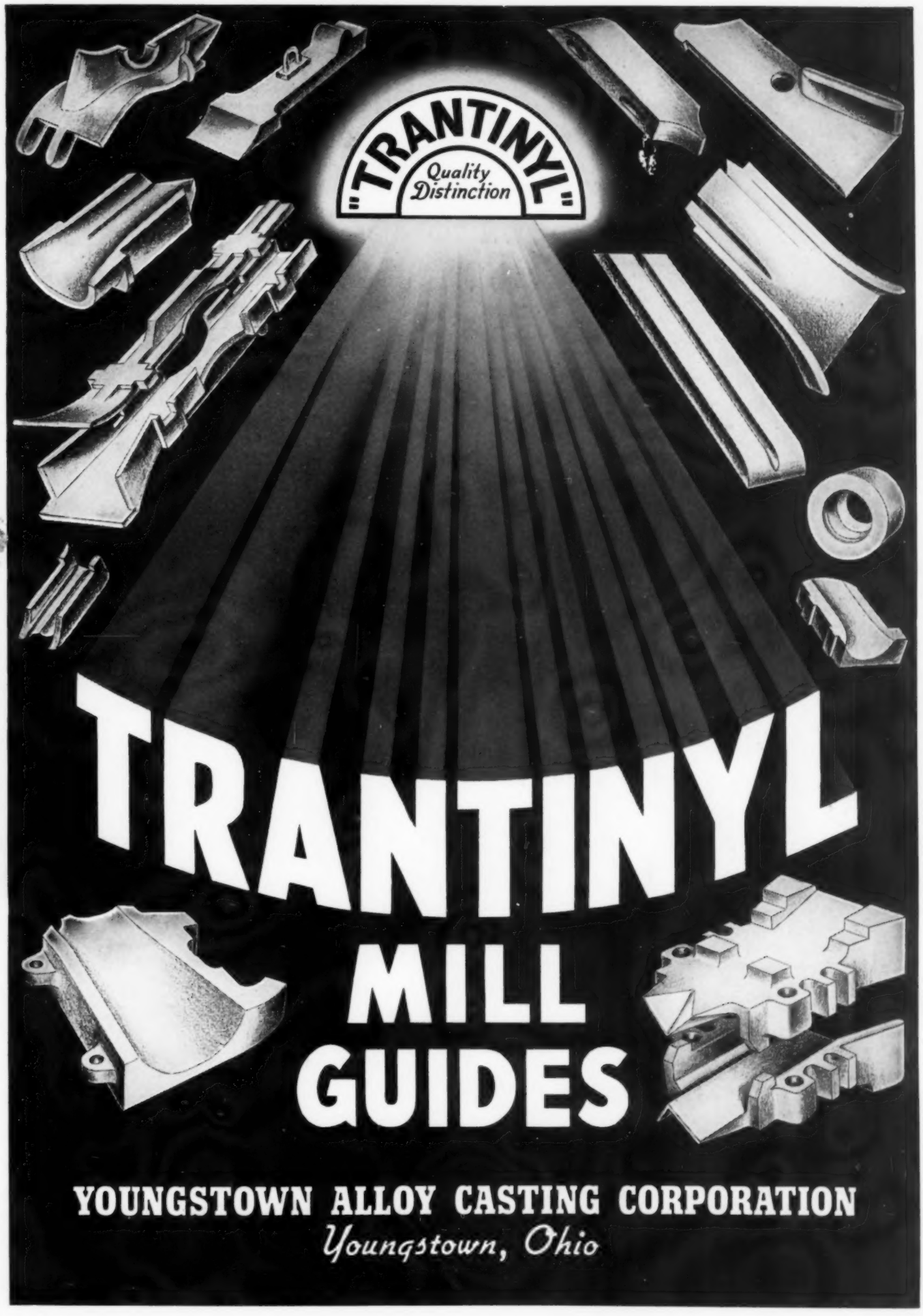
Here's another team of P&H Electric Shovels at work on the Mesabi Range. They're owned by a prominent mining company at Virginia, Minnesota. At left is a P&H Model 1400 (4 cu. yds.). At right is a new P&H Model 1055 Electric Shovel (3 cu. yds.) which incorporates all of the famous P&H features.

P&H ELECTRIC SHOVELS
4455 W. National Ave.
Milwaukee 14, Wisconsin

HARNISCHFEGER CORPORATION

Every third P&H Electric Shovel sold is a repeat order

ARC WELDERS and ELECTRODES • SOIL STABILIZERS • CRAWLER and TRUCK CRANES • DIESEL ENGINES • CANE LOADERS • PRE-ASSEMBLED HOMES


TRANTINYL
Quality Distinction
TRANTINYL
MILL
GUIDES
YOUNGSTOWN ALLOY CASTING CORPORATION
Youngstown, Ohio

Two Wilputte Batteries–

total 122 ovens –

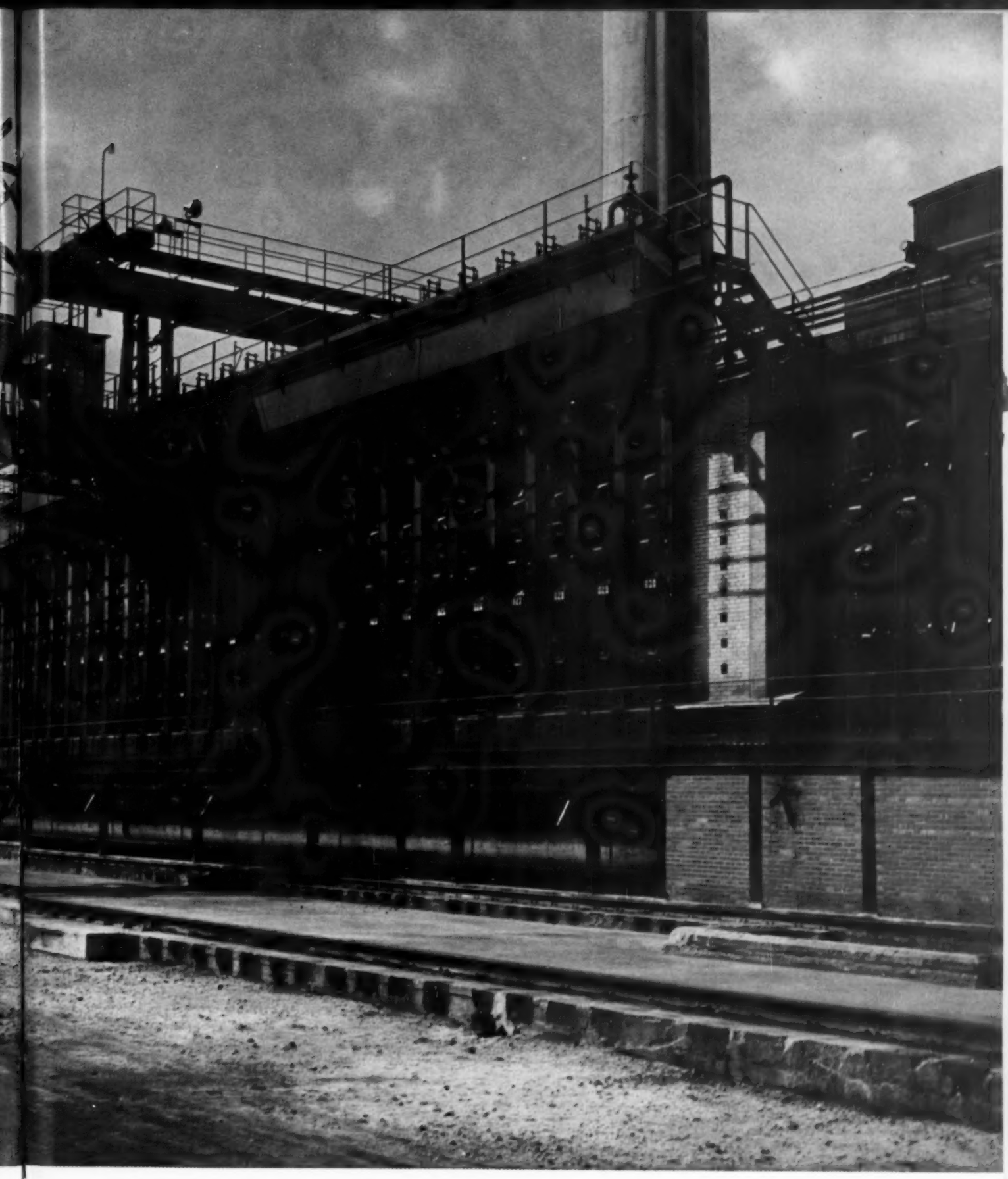
placed in operation at the

Carnegie – Illinois

Clairton plant

during 1950.

WILPUTTE



COKE OVEN DIVISION

ALLIED CHEMICAL & DYE CORPORATION

30 RECTOR STREET • NEW YORK 6, NEW YORK

Roll More Tons per pass with PARALLOY

REGISTERED TRADE-MARK

The Quality Name in

PINCH ROLLS
COILER ROLLS
TENSION ROLLS
STEEL MILL ROLLS

No Scratching or Galling

500-600-BRINELL

Also Makers of

DUCTILE IRON

... A Recent and Revolutionary development in the casting industry.

Other Y&T Products

- HYDRAULIC SLAB AND BILLET PILERS
- STRIP AND SHEET OILING EQUIPMENT
- SHEET SCRUBBER AND CLEANING LINES
- HOT SAWS—ROCKING AND SLIDE TYPES
- HOT BEDS—COOLING BEDS—TRANSFERS
- BILLET EJECTORS—PINCH ROLL STANDS
- SLITTERS SPECIAL SHEARS AND GAUGES
- TILTING TABLES—TRAVELING AND LIFTING TABLES
- CONTINUOUS PICKLING LINES—ROLLER LEVELLERS
- FURNACE CHARGING EQUIPMENT—FURNACE PUSHERS
- STRIP STEEL COILERS AND REELS—SCRAP BALLERS
- RAILROAD SPIKE FORMING MACHINES—ROLL LATHES
- SHEET GALVANIZING LINES WIRE PATENTING FRAMES
- STRETCHER LEVELLERS—ANGLE AND SHAPE STRAIGHTENERS
- ROLLING MILL TABLES—GEAR AND INDIVIDUAL MOTOR TYPES
- MACHINERY BUILT TO CUSTOMER'S DESIGN AND DETAIL DRAWINGS

The Youngstown Foundry & Machine Co.

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

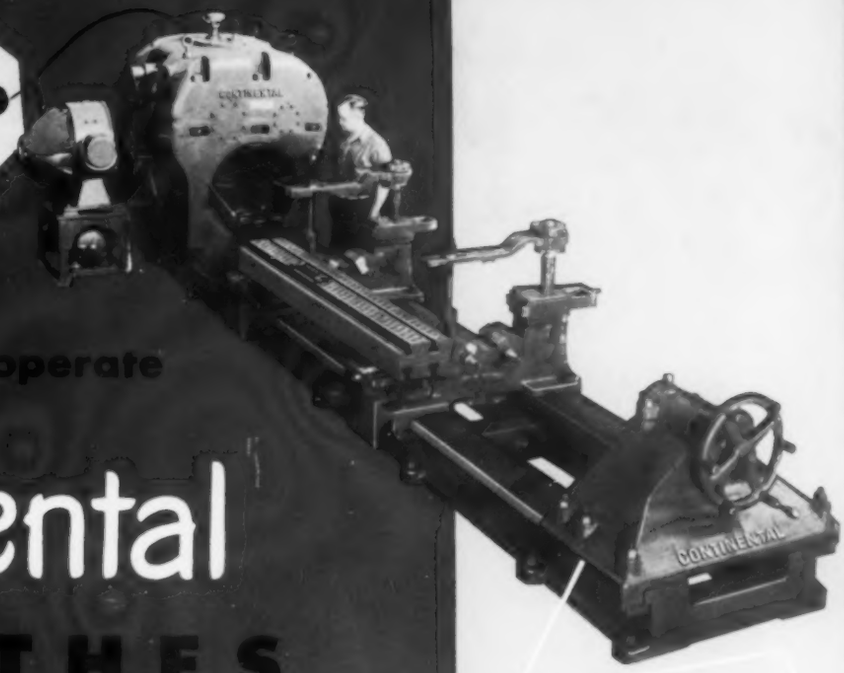
Youngstown, Ohio

Known to Excel...

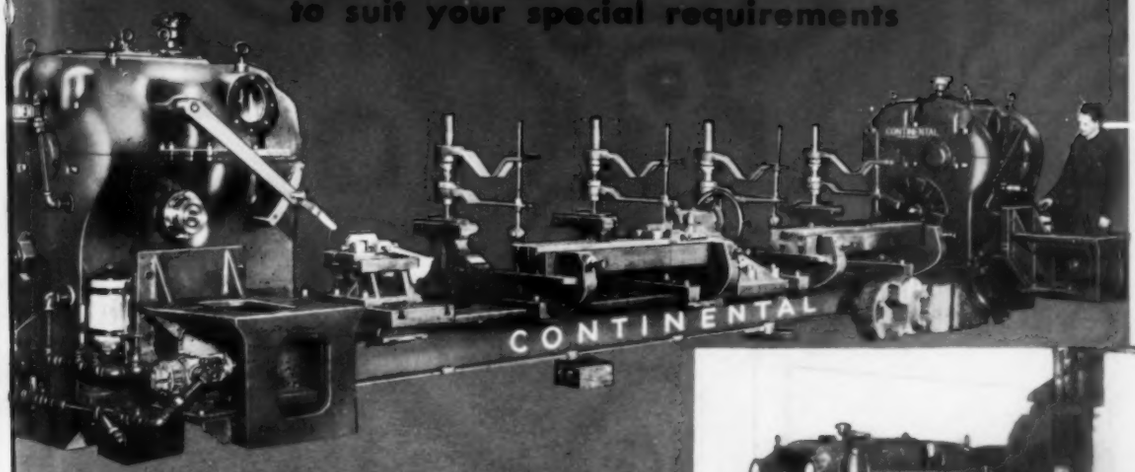
Ask the men who operate

Continental
ROLL LATHES

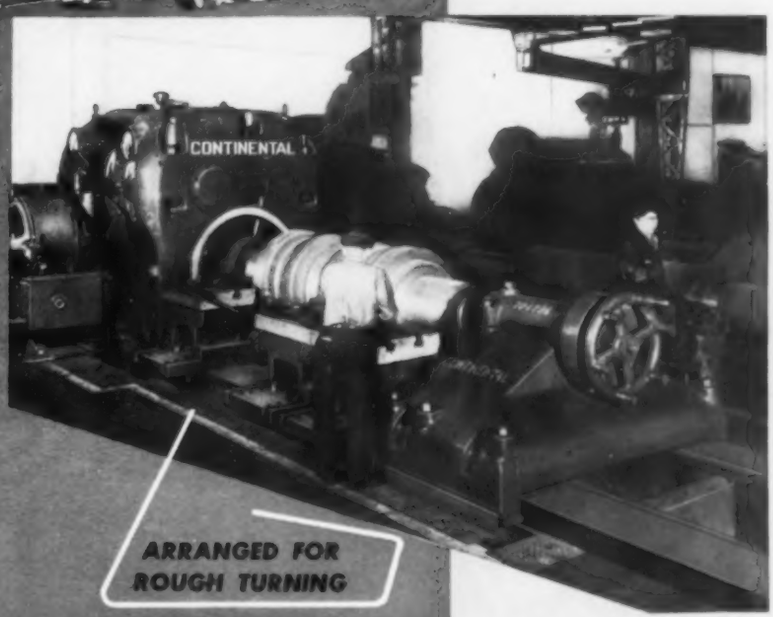
Seven standard sizes arranged to suit your special requirements



ARRANGED FOR FINISH TURNING



ARRANGED WITH DOUBLE HEADSTOCK



ARRANGED FOR ROUGH TURNING

CONTINENTAL ROLL LATHES are designed for the heavy duty service encountered in roughing rolls at the foundry as well as for the precision required for finished turning of rolls in the mill. Seven standard sizes will accommodate all roll sizes from rod mill rolls to plate mill back-up rolls.

Continental

Continental
FOUNDRY & MACHINE CO.

CHICAGO • PITTSBURGH

Plants at East Chicago, Ind. • Wheeling, W. Va. • Pittsburgh, Pa.

CASTINGS: Carbon and Alloy Steel; from 20 to 250,000 Pounds.

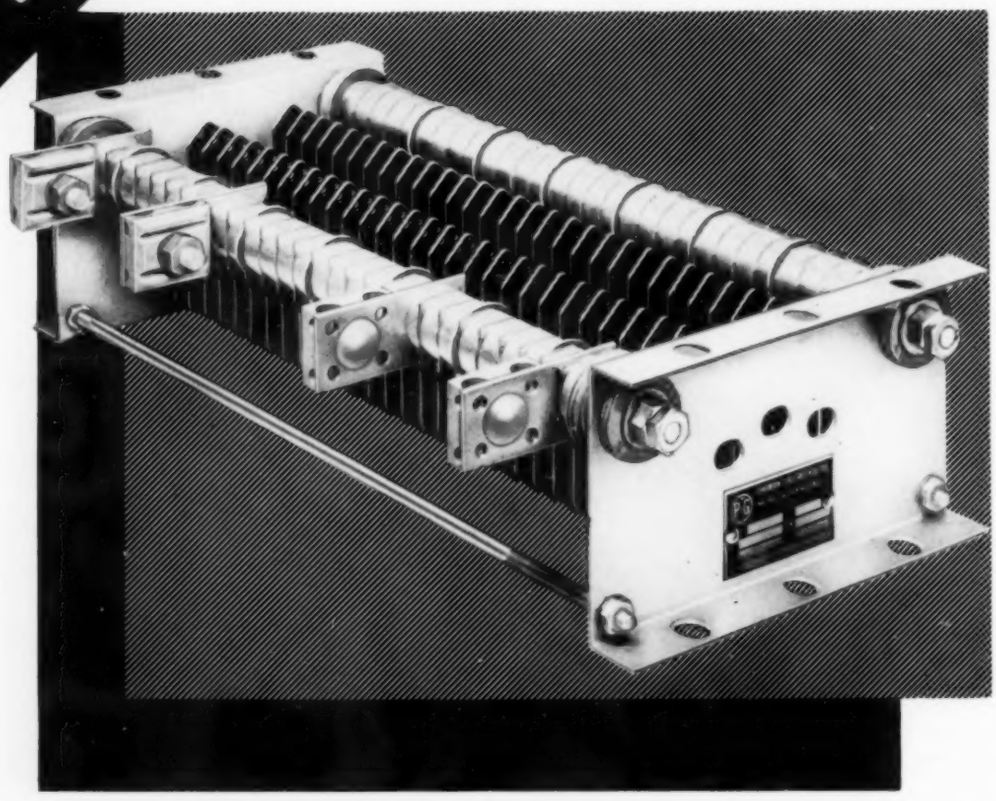
ROLLS: Iron, Alloy Iron and Steel; for All Types of Rolling Mills.

MILLS: Complete Installations of Rolling Mills and Auxiliary Equipment

P-G *Steel Grid Resistors . . .*

HAVE MAXIMUM VENTILATION

Resistor life depends on adequate ventilation and how efficiently heat may be dissipated . . . P-G grid design equalizes the amount of air space surrounding each leg or loop to obtain even heat throughout the grid area. (Note illustration.) . . . Since heat is rapidly and evenly dissipated, hot spots fail to develop and longer resistor life is assured . . . For a nonbreakable resistor (only steel and mica used) specify P-G on your next application.

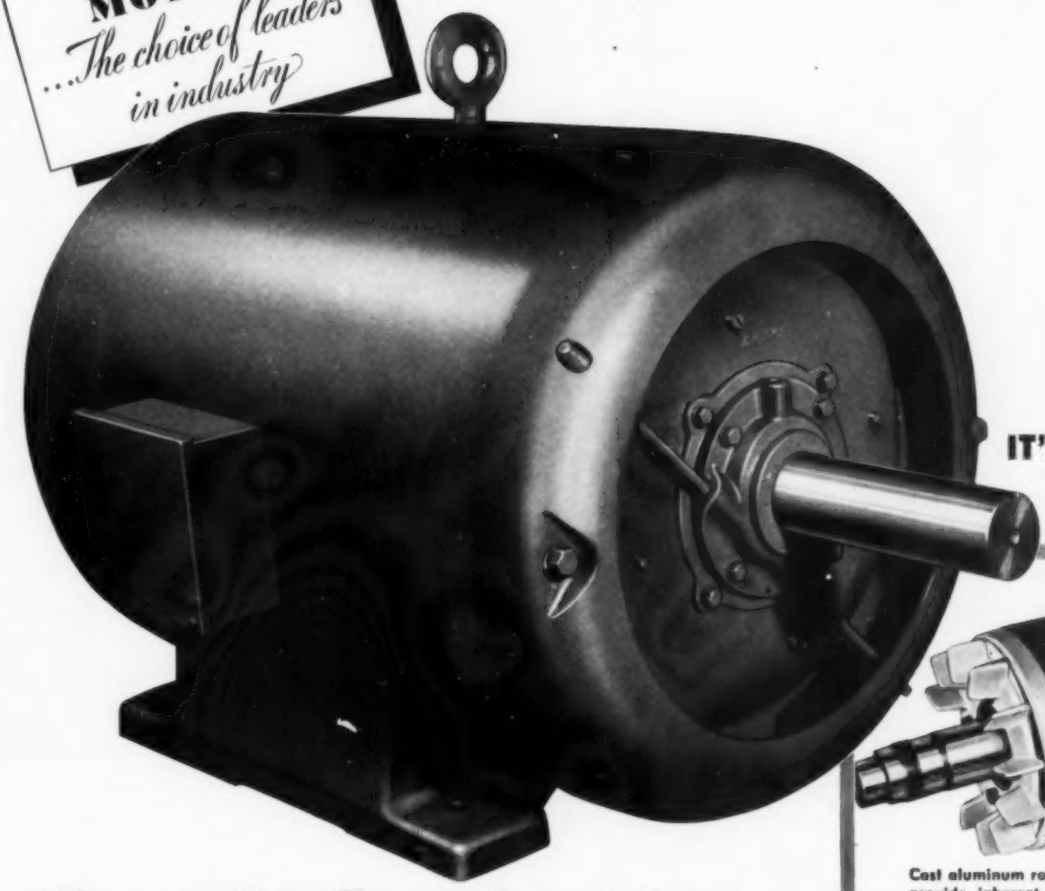


BULLETIN No. 500
Gives detailed information
Copy on request

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY
• ESTABLISHED 1892 •
221 WEST THIRD STREET, CINCINNATI 2, OHIO

WAGNER MOTORS
...The choice of leaders in industry

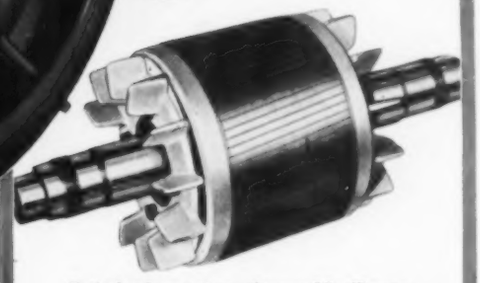


Wagner Totally-enclosed Motors *best* for really dirty jobs!

Wagner totally-enclosed fan-cooled motors are designed for a particular purpose—to operate efficiently and safely under conditions that would quickly damage an ordinary open type motor. In really dirty jobs—in atmospheres filled with dust, fumes, moisture, abrasives, steel chips and other harmful elements—these *protected* Type CP Motors keep on working, delivering dependable power with no maintenance other than periodic lubrication. Wagner totally-enclosed fan-cooled motors are varied electrically to suit a wide variety of application requirements.

Bulletin MU-185 gives complete information on Wagner Motors. Twenty-nine sales and service branches, in principal cities, are ready to help you on any motor problem. In addition, almost 500 authorized motor repair shops provide speedy, nationwide service facilities.

IT'S WAGNER *because:*



Cast aluminum rotors, pioneered by Wagner, provide inherent mechanical and electrical characteristics that add quality and dependability to Wagner type CP Motors.

The rugged frame, used on Wagner type CP Motors, has extra large air ducts around the entire stator to prevent clogging and to permit plenty of fan-driven air to cool the motor.

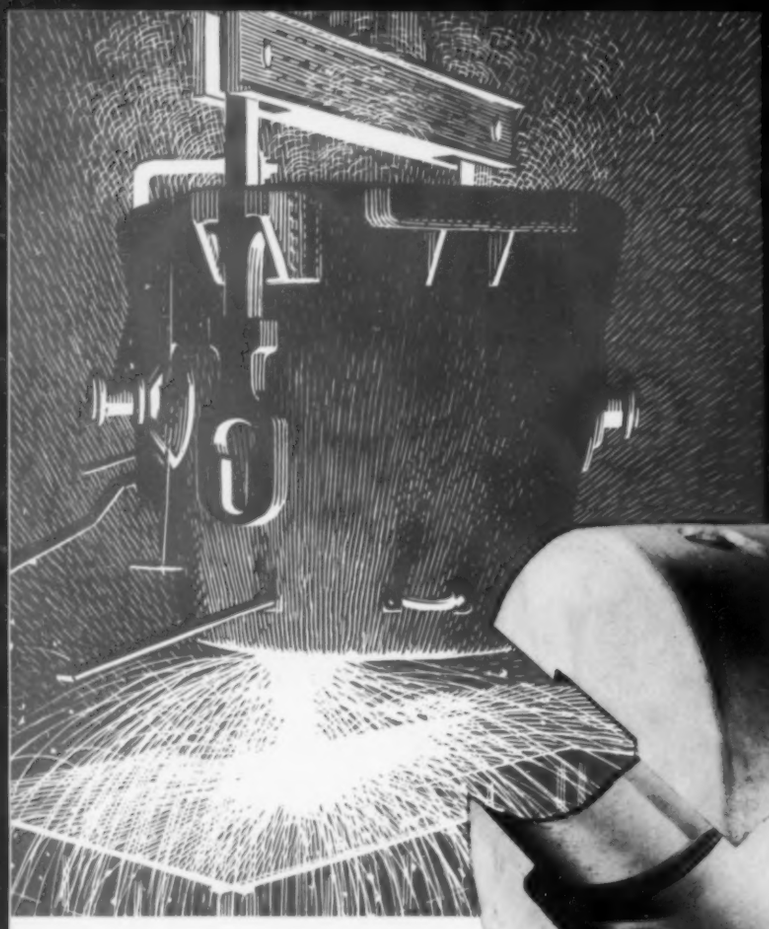
Wagner Electric Corporation
EST. WE 1891

WAGNER ELECTRIC CORPORATION
6483 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS – AIR AND HYDRAULIC

BRANCHES IN 29 PRINCIPAL CITIES

M50-2



Cast UNIVERSAL COUPLINGS AND SPINDLES

give you these advantages:

"UNION" MAKES BETTER:

CHARGING BOXES... PEELS
INGOT CARS
CHARGING BOX CARS
COUPLING BOXES
AND SPINDLES
GEARS AND PINIONS
BLAST FURNACE BELLS
SPECIAL ALLOY CASTINGS
FOR ROLLING MILL EQUIPMENT

1 Less Cost.. 2 Last Longer.. 3 Easier to Machine
4 Less Down-Time for Replacement

Those are not boastful claims, but the actual experience of many mill superintendents on the lookout for production economies. We welcome the opportunity to have you prove to yourself the advantages of Universal Couplings and Spindles cast from high-strength "Univan" or Armor Steel... Before your next replacement, let us give you the facts and figures on a "Union" casting to your exact specifications—either in the rough or completely machined.

UNION STEEL CASTINGS

DIVISION OF BLAW-KNOX COMPANY... PITTSBURGH 22, PA.

Engineered Electrical Control? -that's a CLARK Specialty!

In the 6 year period between 1937 and 1943 The CLARK CONTROLLER COMPANY was chosen to engineer and supply the Electrical Control for 28 Continuous Processing Lines for the Electrolytic Tin Plate Industry.

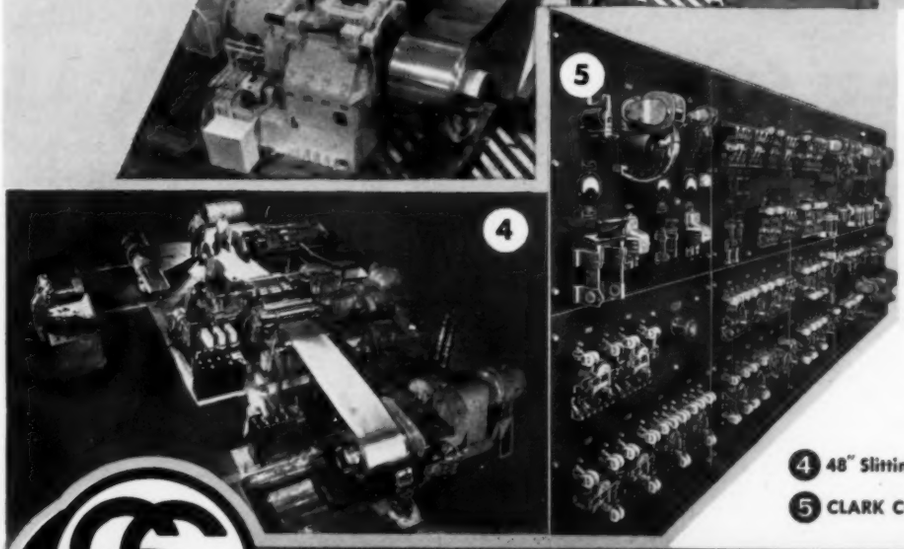
13 Continuous Tinning Lines, 9 Side Trimming Lines, and 6 Brightening Lines made up this total.

Since then, several other Electrolytic Tinning Lines have been or are being built, and CLARK again was selected to provide the control.

1 CLARK DC Control for Electrolytic Tinning Line

2 Entry end of Electrolytic Tinning Line

3 Exit end of Pickle Line



Many shearing lines, slitting lines and other steel mill and industrial processing lines, not connected with tinning lines have also been equipped with CLARK CONTROL.

For successful operation of processing lines, users find that CLARK ENGINEERING provides the "KNOW-HOW."

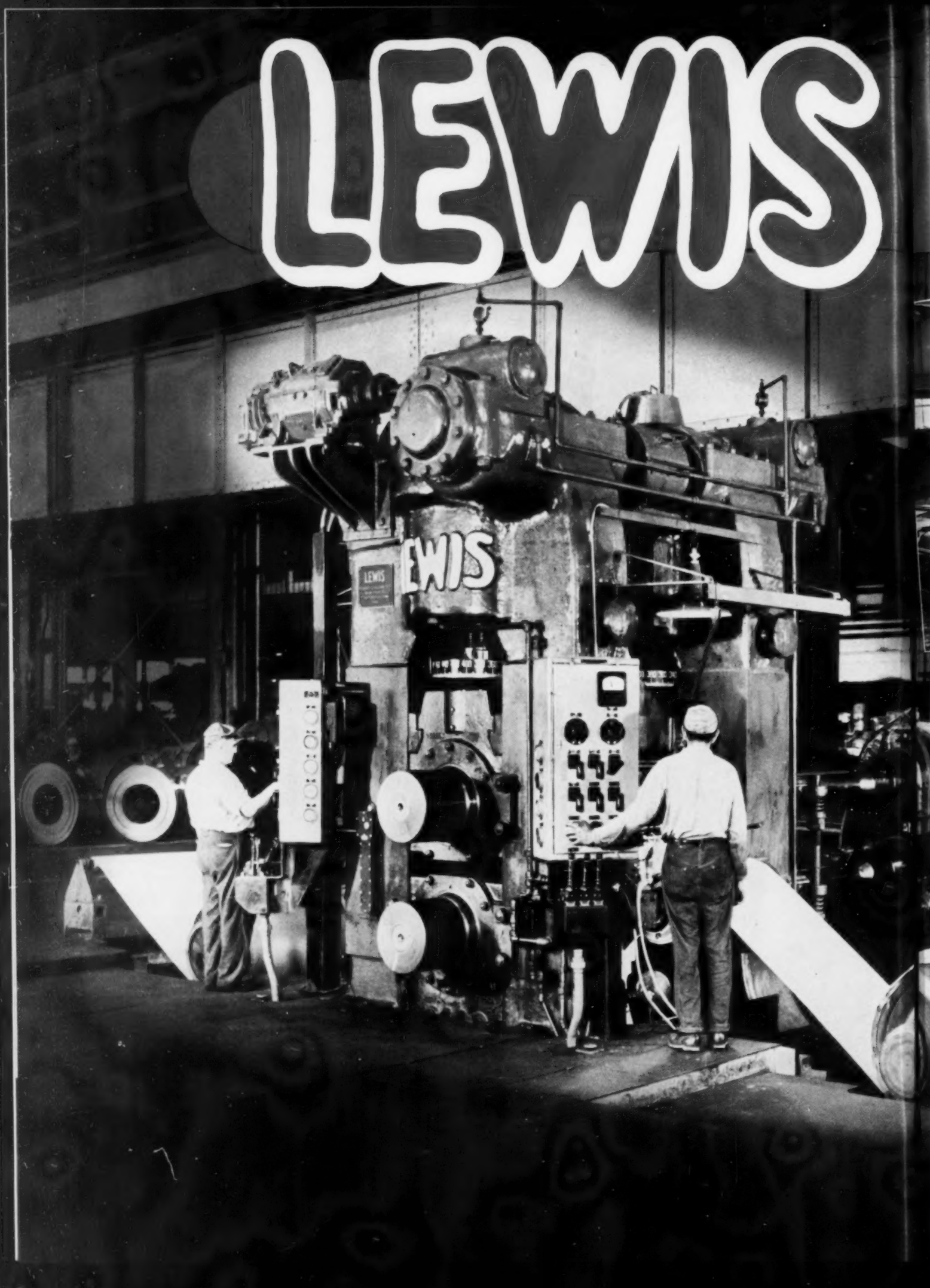
4 48" Slitting Line

5 CLARK CONTROL for 48" Slitting Line

ENGINEERED ELECTRICAL CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152ND STREET, CLEVELAND 10, OHIO


LEWIS
LEWIS
LEWIS

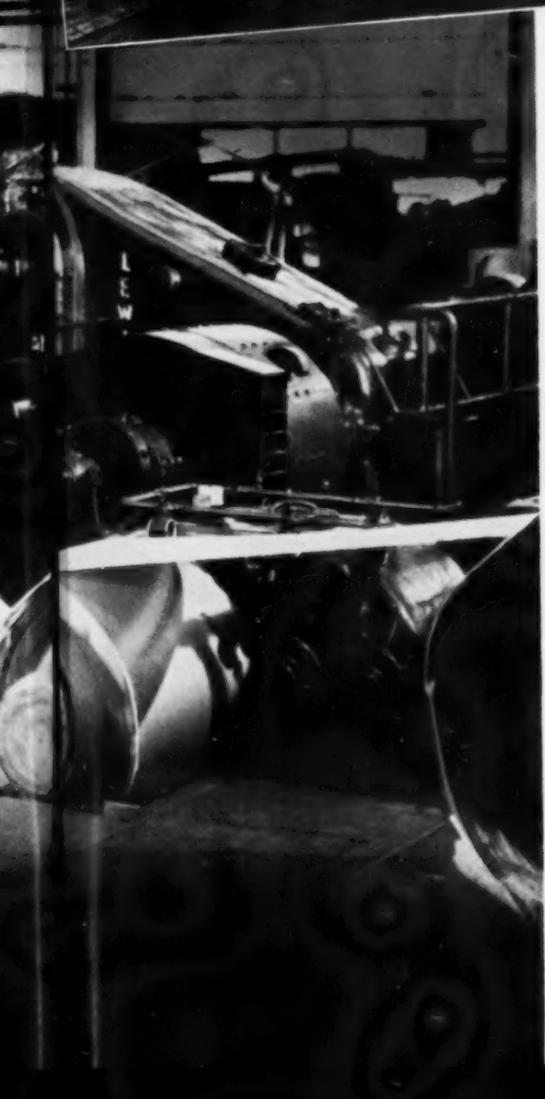
ROLLING MILL EQUIPMENT....

A Lewis 28 x 42 inch two-high skin pass mill at the West Leechburg plant of Allegheny Ludlum Steel Corporation.

This mill will handle stainless steel strip in coils up to 60 inch diameter and 15,000 lb. weight.

The mills are equipped with motorized screw-down, roller bearing rolls, Universal type spindles and motor-operated sled type roll changer.

This installation is typical of rolling mill equipment which Lewis furnishes the iron, steel and non-ferrous industries. Inquiries are always welcomed.

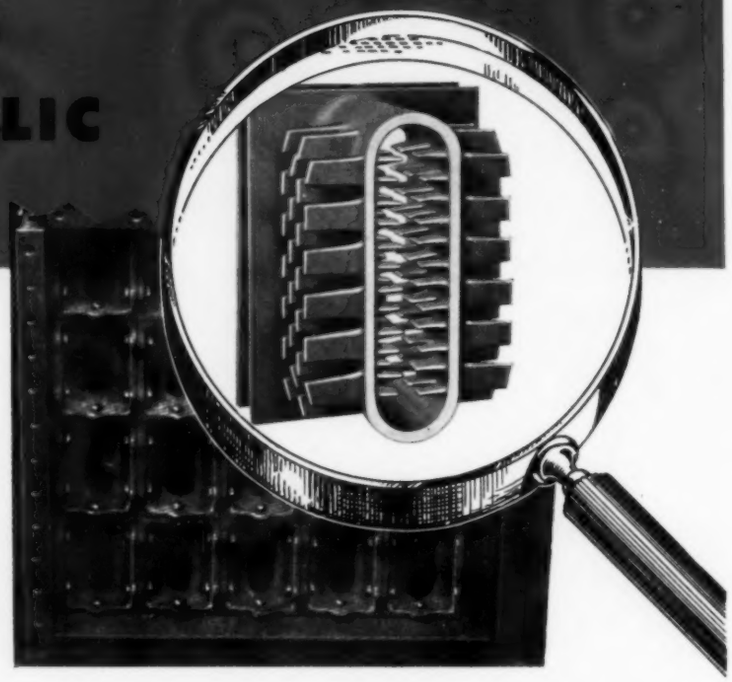


MANUFACTURERS OF
ROLLS AND ROLLING MILL EQUIPMENT
FOR THE IRON, STEEL AND
NON-FERROUS
INDUSTRIES

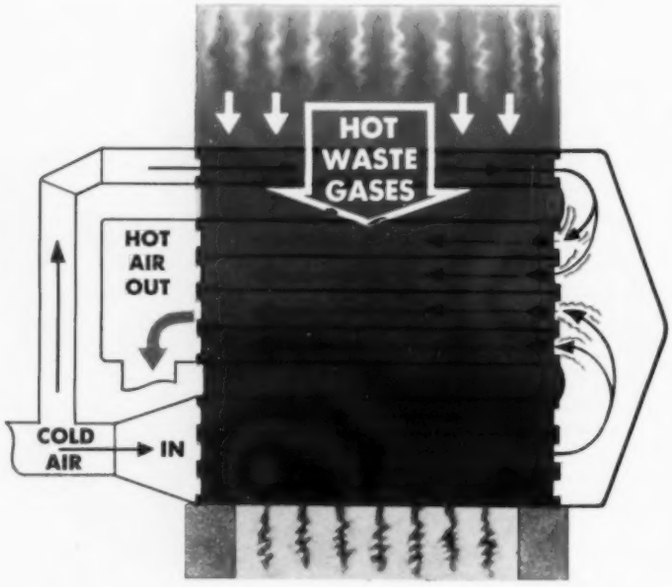
LEWIS FOUNDRY & MACHINE
DIVISION OF BLAW-KNOX CO., PITTSBURGH, PA.

TAKE A LOOK at the heart of industry's most efficient METALLIC RECUPERATOR

Salem Metallic Recuperators bring greater efficiency to industrial furnaces with a progressive method of preheating air required for combustion. Magnified view at right shows the streamlined needles or metal fins (an exclusive feature with Salem) cast on the inside and outside of the heat exchangers. Tips of one set of needles get as hot as the waste gas flowing over them, while the other set holds the temperature of the air stream into which they protrude. The body of the recuperator assumes a temperature midway between the hot and cold extremes, eliminating the possibility of cracks developing in the body of the heat exchange elements.



A bank of Salem Needle Type Metallic Recuperators, with enlarged section showing the needles



Salem's Metallic Recuperator needles produce the most favorable degree of turbulence in air and waste gas streams, providing the maximum transfer of heat from waste gases to the air with a minimum of back pressure.

This improved design makes possible fuel savings up to 30%. Flame temperature is hotter. Leakage is held to a minimum making it possible to maintain constant air-to-gas ratios.

Installations of these heavy cast Salem recuperators have been in constant use for eleven years without replacement.

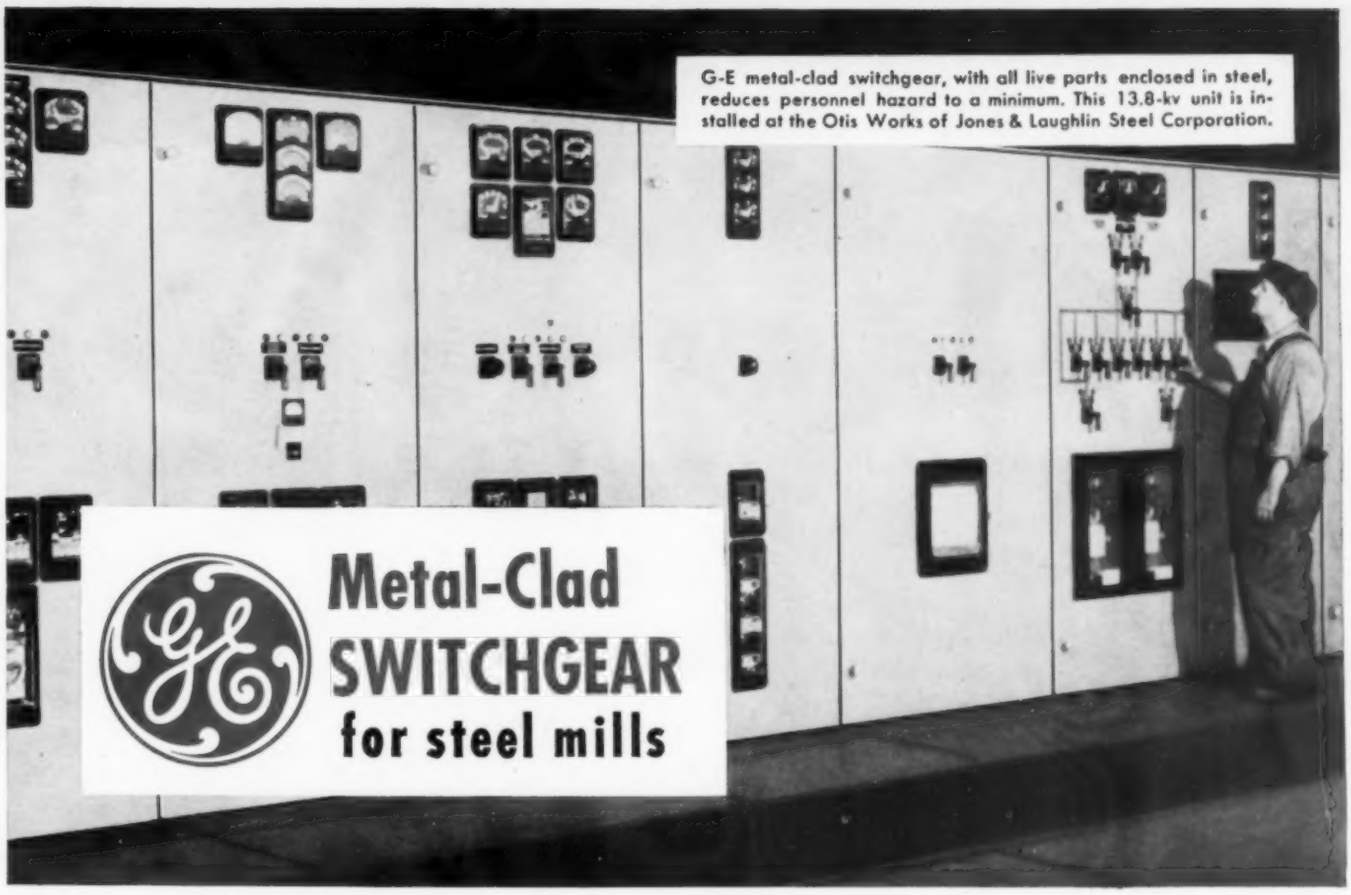
WRITE FOR DETAILS ON YOUR SPECIFIC REQUIREMENTS

Salem Engineering Company

HEADQUARTERS FOR HEAT TREATING DESIGN

Salem, Ohio

SALEM ENGINEERING (CANADA) LTD., TORONTO, ONT.
SALEM ENGINEERING COMPANY, LTD., MILFORD near Derby, ENGLAND



G-E metal-clad switchgear, with all live parts enclosed in steel, reduces personnel hazard to a minimum. This 13.8-kv unit is installed at the Otis Works of Jones & Laughlin Steel Corporation.

Metal-Clad SWITCHGEAR for steel mills

Cuts installed cost of high-voltage systems

Factory-assembled G-E switchgear adds to the economies of 13.8-kv distribution for large, single-area steel mills.

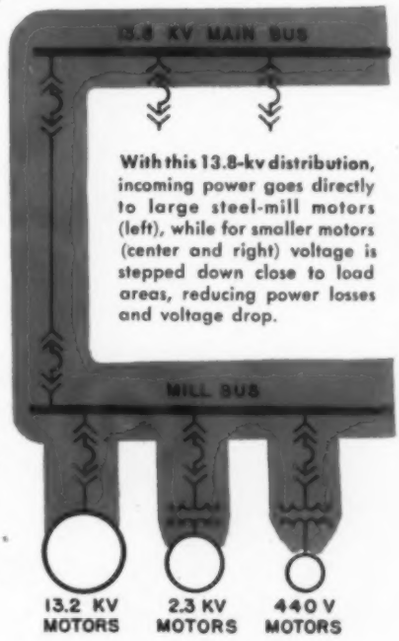
Acceptance of 13.8-kv as a primary distribution voltage—using General Electric metal-clad switchgear—is gaining favor with large, integrated, single-area steel mills.

It is high enough to provide the advantages of high-voltage distribution—lower power losses, reduced voltage drop, lower system cost. And it is also low enough to be applied directly to large steel-mill motors of several thousand horsepower.

Less time, less cost G-E metal-clad switchgear adds many other economies to 13.8-kv distribution. Factory-assembled and shipped to you as a unit, it's installed in less time, at less cost. Metal enclosures protect your personnel. Removable breakers make inspection and maintenance easy. Compact construction saves floor space. And all components are carefully co-ordinated into a complete, efficient unit.

For full information on G-E metal-clad switchgear for high-voltage applications, write today for Bulletin GEA-3083. *Apparatus Dept., General Electric Company, Schenectady 5, New York.*

Ask your G-E representative to arrange a showing of a "Modern Industrial Power Distribution," the full-color sound slidefilm in General Electric's "More Power to America" series.

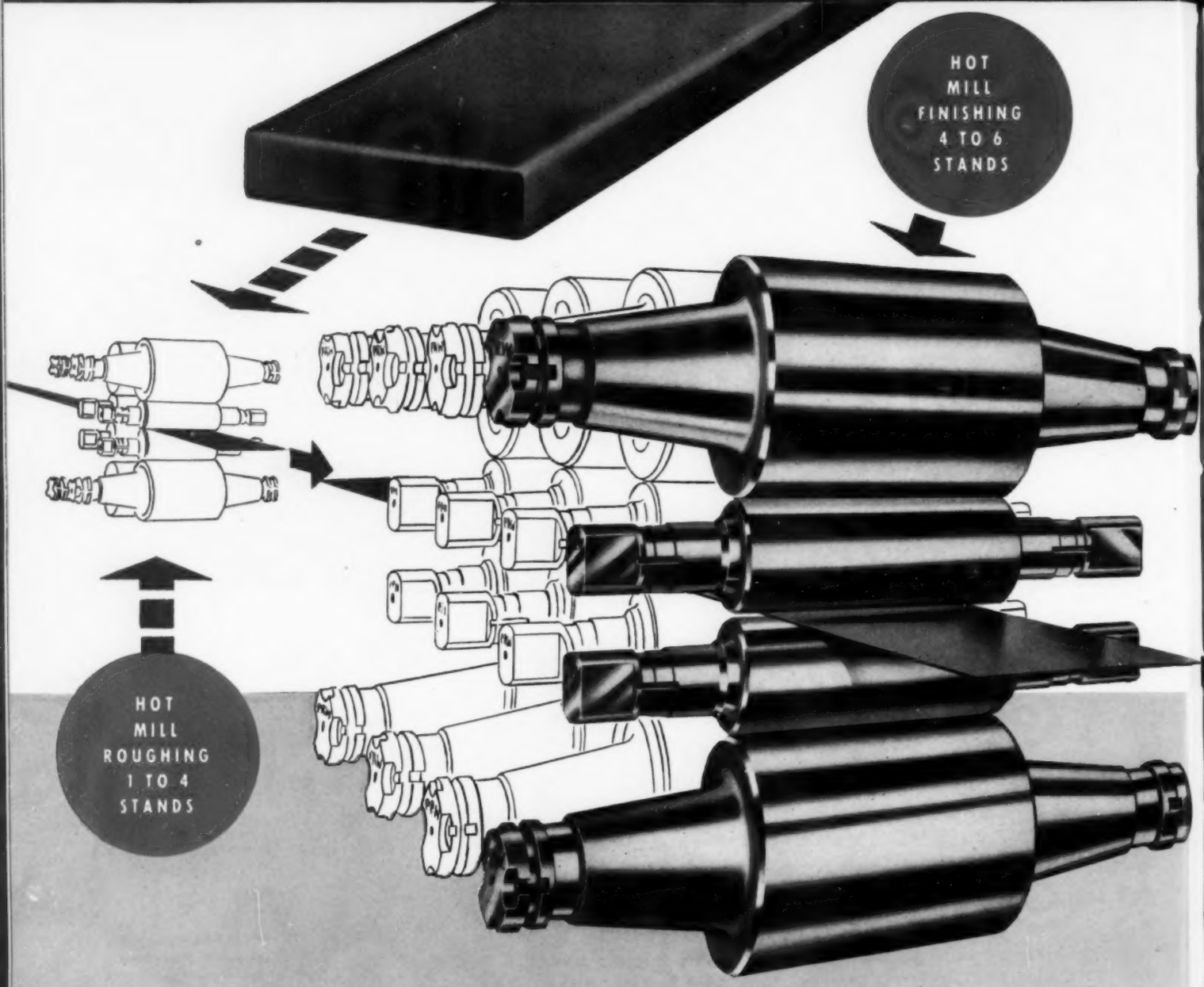


With this 13.8-kv distribution, incoming power goes directly to large steel-mill motors (left), while for smaller motors (center and right) voltage is stepped down close to load areas, reducing power losses and voltage drop.

GENERAL ELECTRIC

659-77

Technique for Rolling Strip

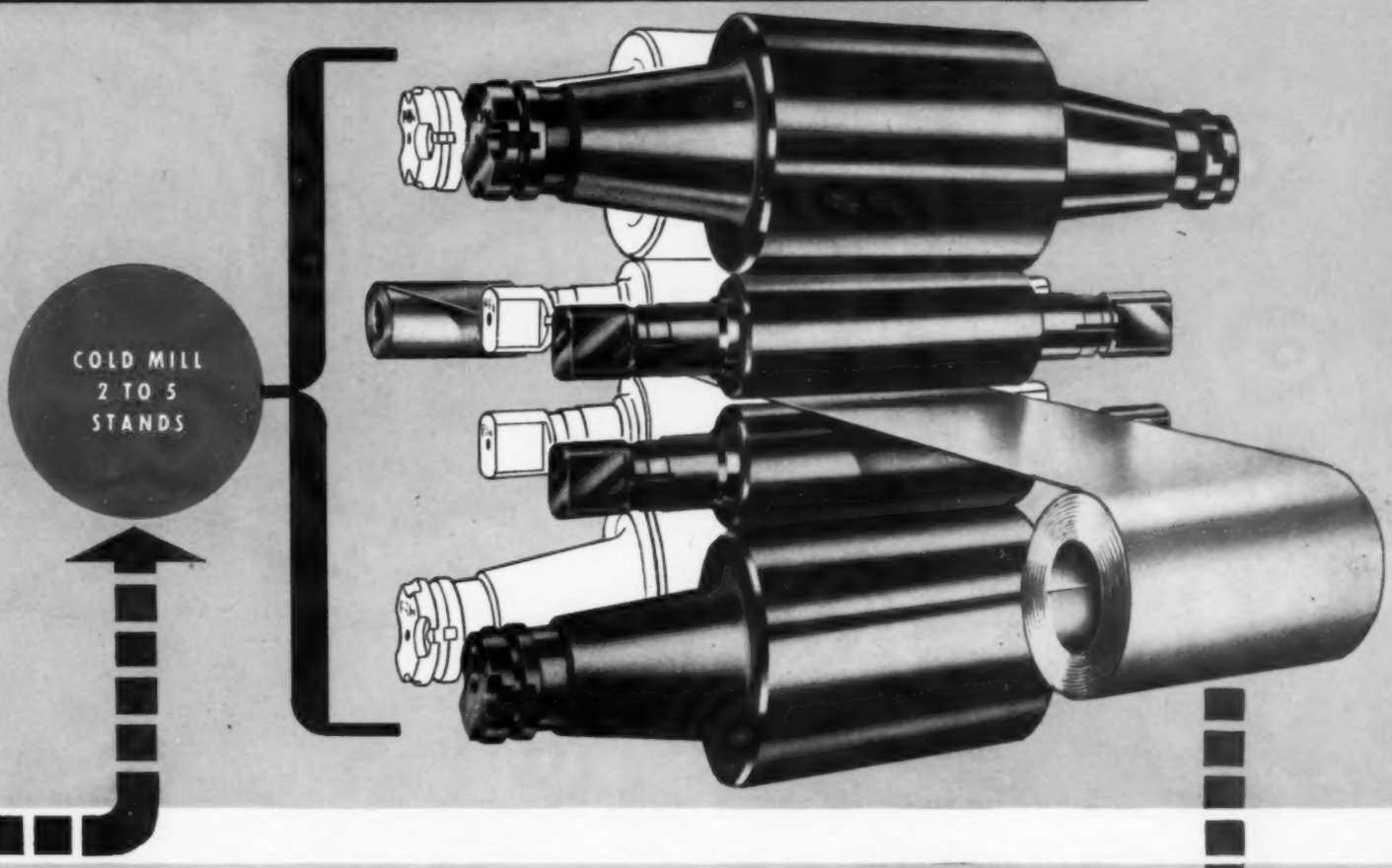


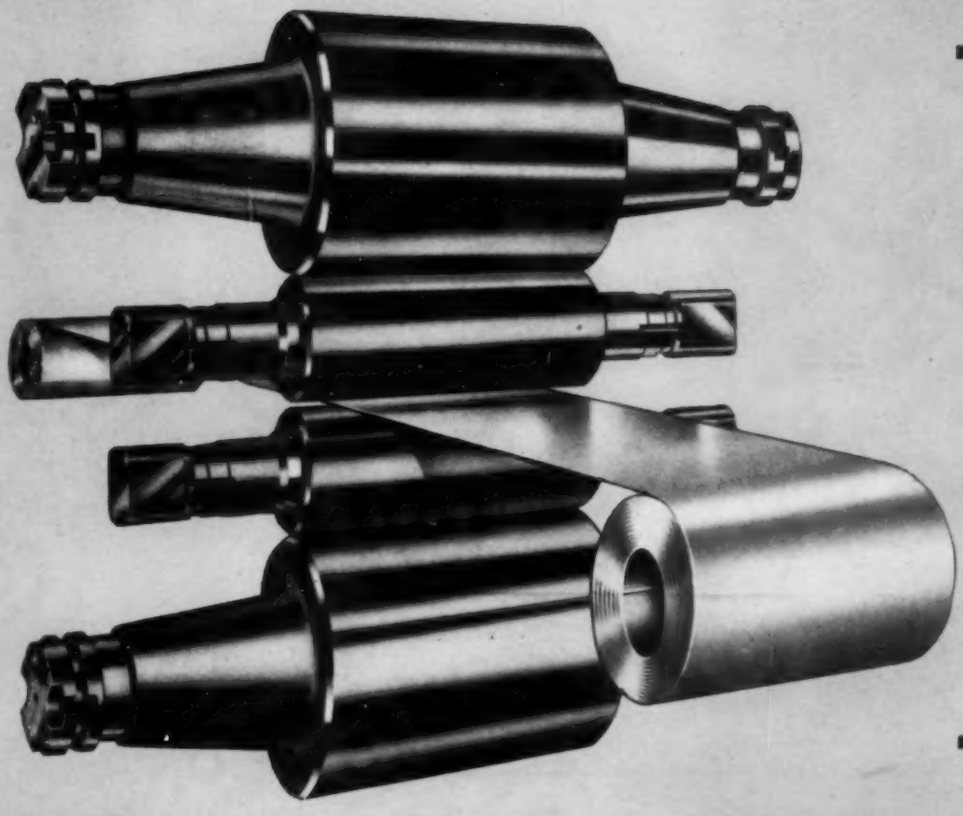
Pittsburgh Grade alloy iron work rolls and Phoenix "A" alloy steel back-up rolls in four high strip mills produce highest tonnages at *less cost per ton of steel rolled.*

PITTSBURGH

Hot and Cold . . .

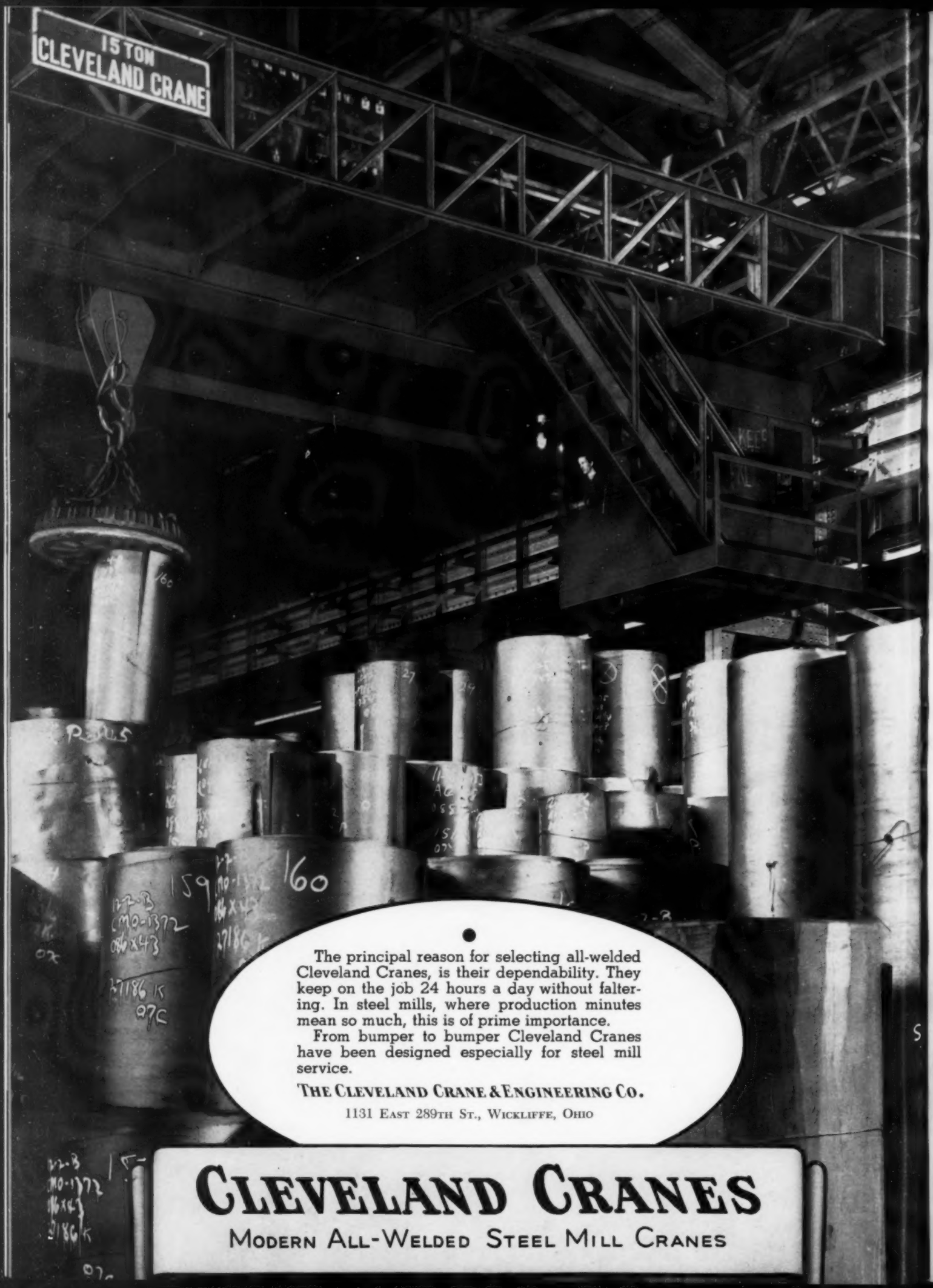
P.R.W.





ROLLS DIVISION OF BLAW-KNOX CO.

PITTSBURGH 1, PENNSYLVANIA



The principal reason for selecting all-welded Cleveland Cranes, is their dependability. They keep on the job 24 hours a day without faltering. In steel mills, where production minutes mean so much, this is of prime importance.

From bumper to bumper Cleveland Cranes have been designed especially for steel mill service.

THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 289TH ST., WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops *and* Shorts

VARIOUS government officials are again "lashing out" at the steel industry for inadequate expansion plans for the next two years. Among others, assistant Secretary of Interior C. G. Davidson, somewhat in disagreement with his superior, Secretary Sawyer, calls the industry timid, and says it does not trust prosperity. Davidson claims the announced expansion "is just not enough to do the job for normal civilian requirements and particularly for meeting military needs." He wants government building of plants, and sees a need for 120,000,000 tons of steel per year for civilian needs plus 5,000,000-10,000,000 tons per year for defense.

To this chorus a new and rather surprising voice was recently added, when C. E. Wilson, president of General Motors Corp., offered some apparently extemporaneous remarks criticizing the steel industry's estimates of the requirements for its products and chiding the industry for not expanding its capacity at a greater rate.

Yet, as late as April of this year, Congressman Celler told B. F. Fairless "United States Steel is too big, Mr. Fairless." And within the past month, administration agencies refused to approve purchase of war-time aluminum facilities by Aluminum Co. of America unless the company would promise to shut down plants of equal capacity.

▲

PERHAPS not the least obstacle to wholesale expansion of steel capacity is the fact that it now costs $250-$300 per ton of annual ingot capacity to reproduce existing facilities which today have market values of $40-$80 per ton of capacity.

▲

THE house organ Hiltonitems describes Utopia as 1950 wages, 1926 dividends, 1932 prices and 1910 taxes.

▲

THE social impact of television upon our population is perhaps greater than we realize. Printers Ink, reporting on a recent survey, quotes one woman as saying: "I got the set to keep my husband home every night. But he's crazy about wrasslin'. I hate it. So now I go out every night." And not to overlook the economic effects, another woman said: "My husband used to go out and get drunk every night. We got the set and now he gets drunk at home. It's much cheaper."

RECENTLY, President Truman said he would not appoint John L. Lewis dogcatcher, and the latter replied that he could understand that, as it would be embarrassing to have more brains in the dog department than in the state department. Beyond appreciating this repartee, we view it with mixed emotions. We are glad that we have a country in which we can still criticize government, but we are sorry that there could be a possible basis for the Lewis reply. And we can't help but think it too bad that brains aren't always accompanied by good judgment.

▲

NOT all men are homeless but some are home less than others.

▲

ACCORDING to A. R. Hellwarth, of the Detroit Edison Co., industry invests at least $10,000 and two years of irreplaceable time before a newly recruited engineer is able to accept the full responsibility of a job in a modern industrial organization.

▲

RECENTLY, when a man failed to return home from a nearby city, his wife wired five of his good friends, saying: "George hasn't come home. Is he spending the night with you?" Before long, five replies were received, all reading: "Yes, George spending night with me."

▲

IT'S sometimes hard to tell whether folks have dropped in for a call or called in for a drop.

▲

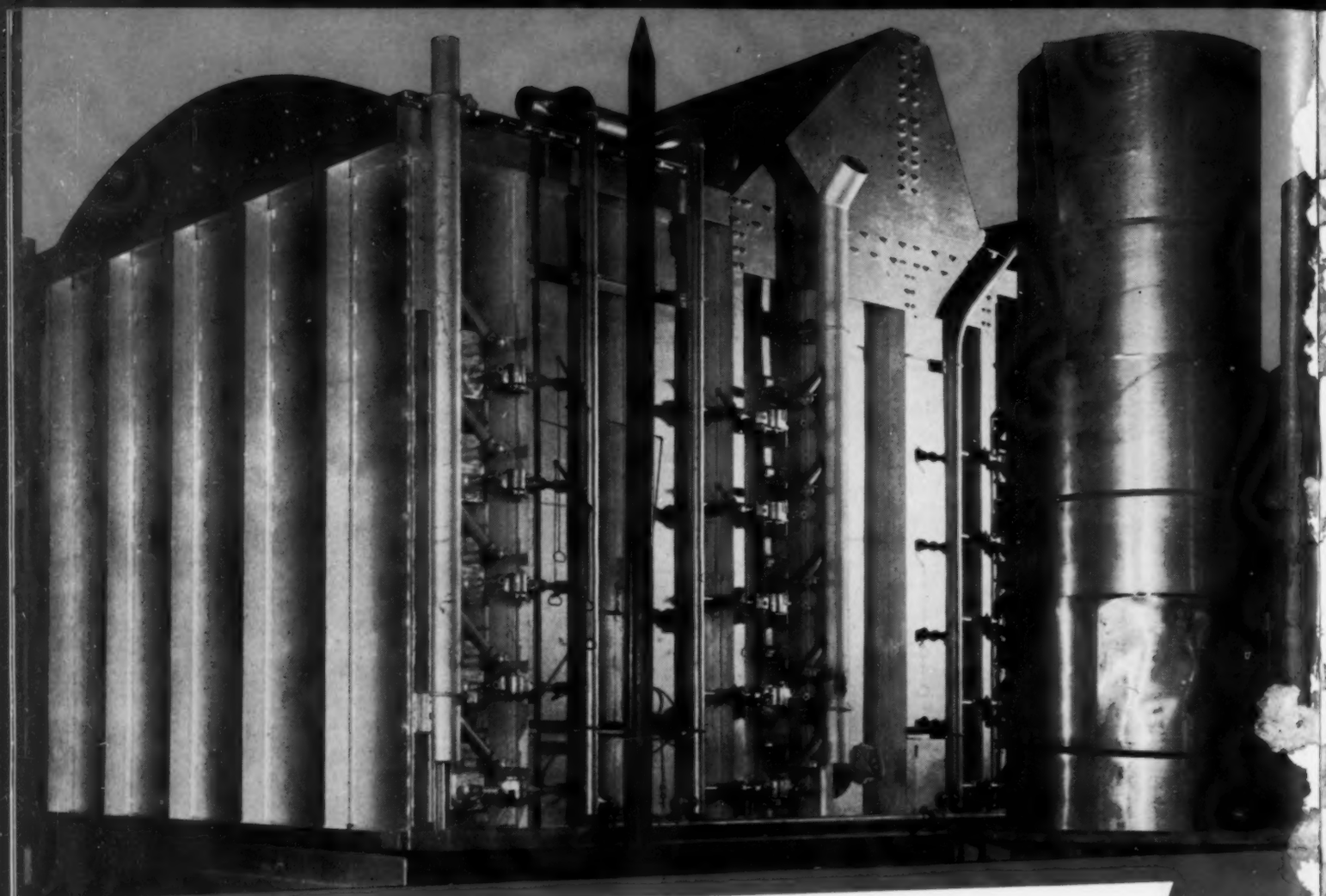
Income tax blank — 1960:

1. Total income for the year ..... ———
2. Expenses for the year ..... ———
3. Balance left ..... ———
4. Send it in.

▲

Guess Who!

This surveying crew functioned back in 1914 in the construction of a steel plant. At least three of the group are still connected with the steel industry. Let's see how many you can name. The answer will appear on this page next month.



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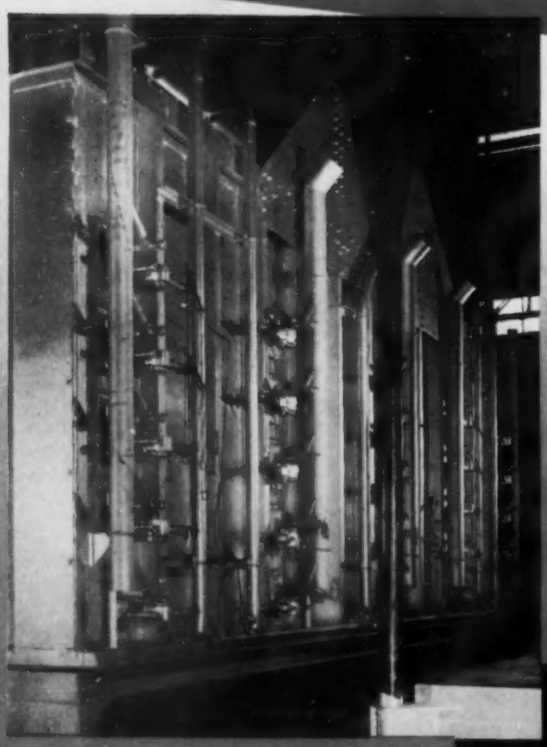

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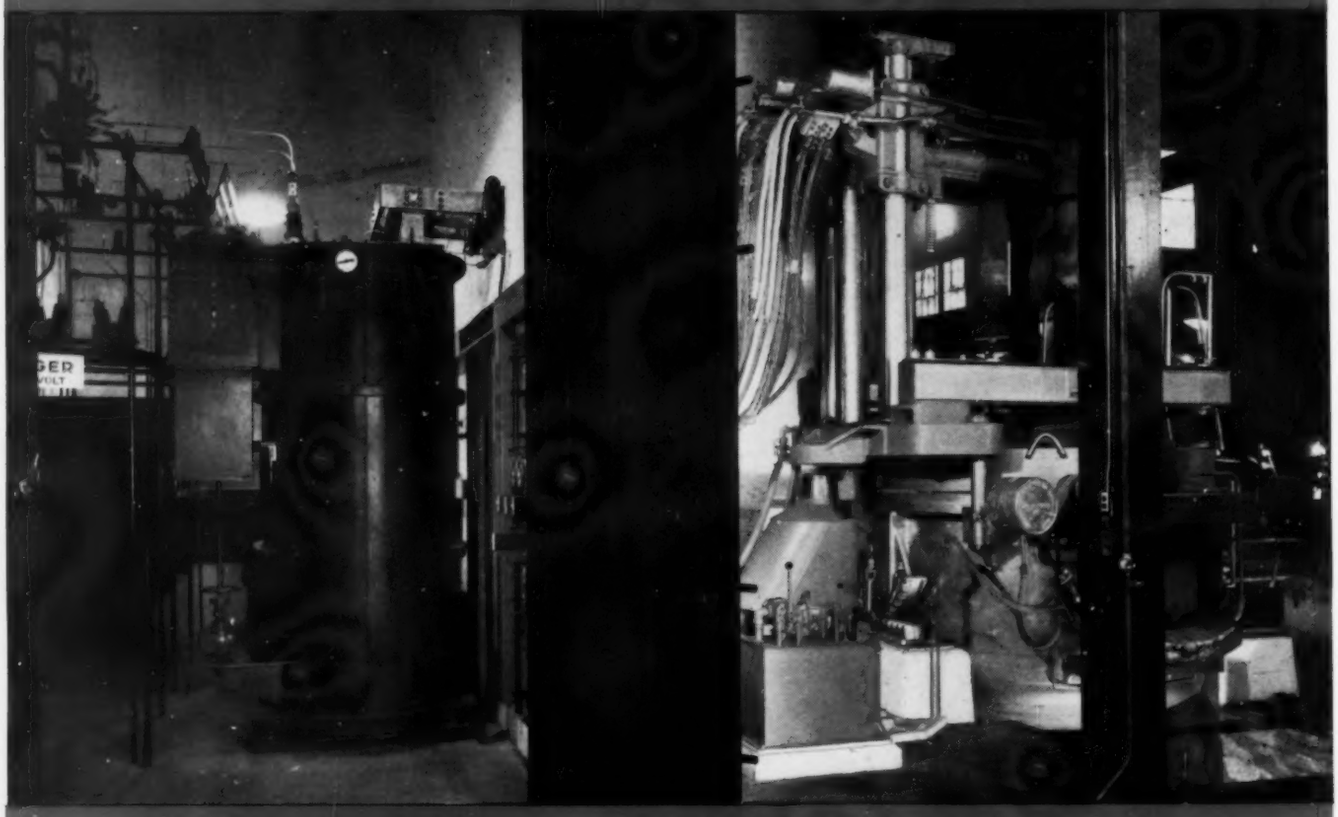

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WHEN YOU MELT... MOORE RAPID *Lectromelt*

AUTOMATIC SELF-CENTERING ROLLS AND PULLEYS

By E. T. LORIG, Chief
Senior Staff Engineering Bureau
Carnegie-Illinois Steel Corp.
Pittsburgh, Pa.

. . . . the increasing emphasis on continuous processes lends great importance to the self-centering roll which has been recently developed . . . .

▲ THE tracking and aligning problems encountered in the processing of cold wide light gage flat metal strip in continuous lines for pickling, cleaning, shearing, electrolytic tinning, continuous galvanizing, etc., since the development of continuous hot and cold metal strip rolling many years ago, have never been fully solved. The comparatively recent trend toward larger coils and longer strip, increased processing line speeds, and longer processing lines and belt conveyors have aggravated these tracking and aligning difficulties materially. A careful study has therefore been made of strip processing equipment with a view toward improving the tracking and aligning of metal strip, reducing high concentrated detrimental strip tensions, and relieving or preventing damage to the strip because of the apparent faulty guiding.

STUDIES OF CONVEYOR ROLLS

An intensive study of metal strip handling through processing lines and over conveyors has been made. This study involved mathematical calculations concerning present practices utilized in securing tracking and aligning of flat strip metals being forwarded over conventional, rotating deflector and conveyor rolls and was supplemented by data secured from motor driven models. In these models, various type of rolls were incorporated not only to prove or disprove the mathematical determinations made, but also to observe and record reactions most difficult of mathematical calculation.

The mathematical determinations, together with the reactions observed in operating the experimental model units under many conditions, resolved themselves into a study of the planar action at rotating roll surfaces and in the materials being conveyed over such rolls, both of which must be given consideration simultaneously if exact knowledge of the reactions that take place is to be secured.

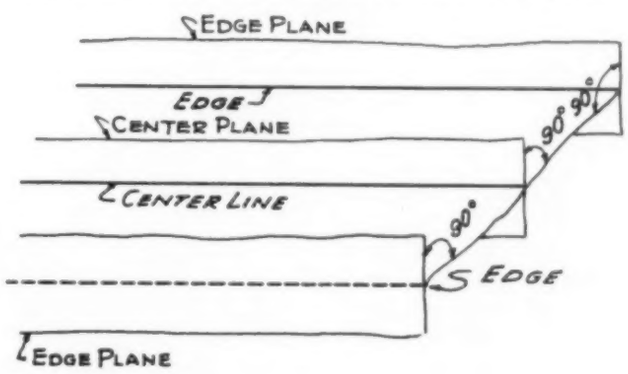
This study, initiated and undertaken by Carnegie-Illinois Steel Corp., led to a novel and rather simple solution to many of these problems and the development of self centering rolls.

ACTION TAKING PLACE IN CONVENTIONAL EQUIPMENT

Before proceeding with descriptive matter pertaining to the action of self centering rolls, it may be helpful to review briefly the conclusions reached in the study of the reactions that take place in passing strip over conventional continuous bodied rolls. A more detailed discussion of this subject is presented later in the paper. (For definitions of terms in connection with planes referred to below see Figures 1, 2 and 3). Those conclusions are:

1. Cylindrical continuous-bodied rolls, when used for deflecting or for changing the direction of strip-like materials, have no inherent ability to center

Figure 1 — Sketch illustrates the planes in flat strip.



and align the cross sectional area at the line of contact on the rolls; with the result that the strip edges move laterally and continue to move off the transverse centerline of the rolls in either direction as the rolls are rotated and the strip is forwarded. It has been common experience that mechanical alignment and parallelism of such rolls cannot be maintained to prevent excessive lateral movement of the edges of commercial strip.

2. It should be recognized at this point that all planes perpendicular to the roll axis and intersecting the surfaces of continuous bodied rolls remain very closely parallel to one another under operating loads. Bending of the roll bodies under extreme applied loads is the only factor that can change this. In actual practice, under reasonable strip tensions and bearing load on the rolls, this bending can be considered negligible as far as maintaining satisfactory strip alignment is concerned. The intersecting planes in the arced section of the moving strip in contact with the rolls also remain very closely parallel to one another and rotate in exact alignment with those of the rolls being contacted.

   Thus, the planes of the rotating rolls and those of the arced section of the strip in contact rotate in exact parallelism so long as contact exists between roll body and strip over the full width.

   Flat light gage strip of all kinds can always be flexed over cylindrical rolls with relative ease in any direction with respect to its longitudinal edges and centerline without encountering distortion in the strip (Figure 3). Wrapping paper helically over a cylindrical mandrel to form a mailing tube is a good example. Thus, it becomes apparent that while the planes in conventional rotating rolls remain in exact parallelism with those of the contacting arced section of strip being forwarded over the rolls, yet the strip edges and centerline lie in three separate and distinct planes vertical to the strip surface. These planes are constantly being forced out of parallelism in either direction with the unidirectional planes in the main body of that section of strip passing over the rolls.

   What causes the strip edges and centerline to be forced out of parallelism with the unidirectional planes in the strip arced over the rolls? The contributing factors are: a. Inaccuracies in manufacturing the strip itself, b. Inaccuracies in the machining of contacting rolls, c. Inaccuracies in the alignment of such rolls one with another, d. Nonuniform contact pressures between rolls and strip, e. Inability to maintain equipment in perfect alignment, and f. Localized temperature changes involving unequal expansion and contraction of the strip and equipment.
   These are the major factors catering to the misalignment of strip edges and centerline passing over a series of conventional cylindrical rolls.

3. To automatically maintain relatively good tracking of flexible strip and belt-like materials of all classifications, such as rubber, composition belting, textiles, metals of all kinds, paper, plastics, etc., over a series of conventional continuous bodied rolls in reasonable parallelism and alignment, rather highly crowned rolls must be used and the crowning effect at the transverse center should be essentially 0.125 in. in diameter differential per foot of roll length. This has been a rule evolved from many years of experience in flat belted applications to avoid excessive lateral movement in either direction, regardless of materials used for the belts, taking into consideration the normal inaccuracies which occur in the rolls and supporting structure, normal changes in alignment of the equipment under operations, etc. There is no reason for assuming that this rule can be changed without resorting to excessive maintenance of equipment accompanied by occasional failures of tracking.

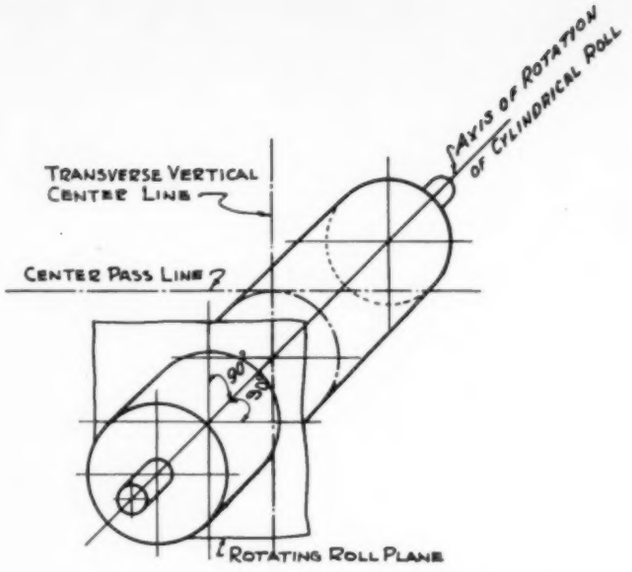


Figure 2 — Terminology used for rolls is illustrated in this sketch.

4. With conventional continuous bodied crowned rolls, automatic tracking of strip-like materials under tension over the rolls is essentially secured by stretching one-half of the strip width sufficiently beyond that introduced by the initial strip tensioning, and by contracting or loosening of the fibres in the other half sufficiently under the same initial tensioning. If the crown in the rolls is sufficiently high as mentioned in Item 3 above, and the initial tension over the full width of the strip is also sufficiently high to secure bearing and frictional contact of the strip over the width of the arced crowned face of the rolls; then the rolls in rotating will, because of the crowning effect, proceed to stretch one side of the strip being forwarded and loosen the other alternately.

   This action will oscillate the strip edges from side to side with respect to the pass line and will recenter and realign the moving strip over the series of rolls. The crown on the rolls will always stretch the moving strip material, on the side or edge that moves laterally, toward the transverse center of the roll, while the side or edges being contracted moves laterally away from this center. This action in effect alternately increases the

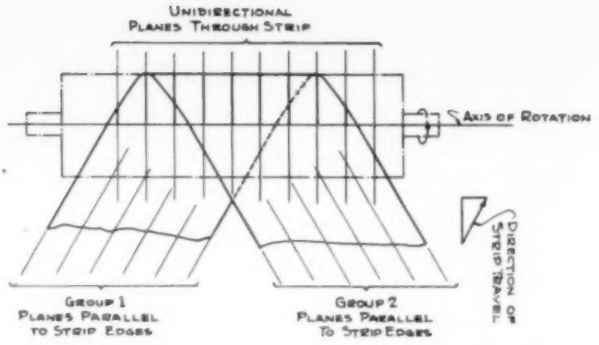


Figure 3 — It is easy to flex strip on cylindrical rolls in almost any direction with respect to its longitudinal edges.

strain in the material on one side and edge and decreases the strain on the other, thereby constantly shifting the position of the three planes in which the two edges and centerline of the strip lie with respect to the center pass line of the rolls. This action changes the angle at which the edges and centerline of the strip approach the axes and parallel bodies of the rotating rolls. With crowned rolls, this constant change in angularity of the strip edges with respect to the center pass line of the rolls on the approach side always tends to angle the strip edges in the proper direction to laterally maintain the strip at the initial point of roll contact closely adjacent to the center pass line of the rolls on either side. It should be recognized that constant minute slippage is occurring between roll and contacting strip surfaces for two major reasons, first the change in linear velocities on crowned roll surfaces from edge to center, and second the change in linear velocity of the strip in being expanded and contracted alternately on each side of its longitudinal centerline. This slippage always causes the mean linear velocity of idler roll surfaces to be less than the linear speed of the strip in contact. Conversely, for driving rolls the mean linear velocity of the roll surfaces is always faster than that of the contacting strip being forwarded.

The constant lateral oscillating or weaving action of the strip edges back and forth over the crowned rolls, accompanied by slippage, may be imperceptible, but the action nevertheless exists in a never ceasing fight of opposing internal forces within the strip to maintain its centerline on the center pass line of the series of conventional continuous-bodied crowned rolls.

5. If conventional deflector or conveyor rolls become slightly hollow in the center or are constructed with a concave surface by intent, then the reaction of the rolls on the strip material in contact is to distort and strain the strip in the opposite directions from those outlined in Item 4 above. Concave rolls would of course create strip distortions and strains such that the strip edge angles of approach to the rolls are reversed, thereby creating a condition whereby no possibility exists of changing this angle automatically from right to left and vice versa to secure recentering and realigning of the strip on the center pass line at the approach side of the rolls. The results would be that the strip edge angle of approach to the rolls would continue to increase in the wrong direction, instead of decreasing as in Item 4 above, because of a continued increase in edge tension as the strip cross-sectional area at the point of contact continues to move laterally away from the center pass line of the rolls. Thus the speed at which the contacting strip edges move laterally away from the center pass line increases in rapidity or at an accelerated rate in either direction, when once off the center pass line, until one edge of the strip is quickly ruptured by accumulative excessive strain or until the edge of the strip quickly becomes fouled on the roll housings or other equipment supporting frame work. With high speed processing lines, the lateral movement of the strip edges can at times be so extremely fast under these conditions that extensive damage to strip and equipment can occur.

6. Low modulus of elasticity products such as rubber, composition belting, textiles, plastics, etc., can in most cases meet the necessary conditions outlined in Items 3 and 4 above for strip, because of their relatively great stretchability within the elastic limit of the materials. Flexing of such materials over comparatively highly crowned rolls, in both longitudinal and transverse directions simultaneously, introduces rather severe stresses and strains accompanied by frictional slippage between roll and materials, if utilized for conveyor or driving belts. The frictional slippage between strip and roll also increases wear on the roll surfaces, tending to destroy the crowning effect and shorten the life of the roll in general.

7. In long metal strip processing lines containing numerous conventional deflector and conveyor rolls, highly crowned rolls such as presently used for low moduli materials cannot be utilized to center and align such strip. Because of the comparatively low stretchability within the elastic limit of metals, very low crowns must be provided accompanied by strip tensions that are higher than desirable, approaching the elastic limit of the material, in an attempt to secure reasonably good tracking. This is not conducive to good tracking and aligning of the strip, however, and to avoid permanent strains and distortion in the metal strip, tensions should be considerably lower than often encountered in practice.

8. Under present operating conditions, the laws governing satisfactory tracking and aligning of low moduli materials do not and cannot readily apply to metals being processed through lines containing conventional deflector and conveyor rolls. With low crowned rolls and high strip tensions now utilized, an initial error in alignment of the strip at the entry end of long processing lines tends to be cumulative as the strip proceeds through the line and approaches the delivery end. Such initial errors in alignment cannot be avoided and tend to cause progressive divergence of the strip centerline and edges from the processing units' center-pass line on either side. This progressive diver-

gence is, of course, caused by too little permissible crown, in conventional rolls for conveying metal strip and too little permissible stretch within the elastic limit of the strip between successive rolls, to change the approach angle of the edges sufficiently to over-balance and overcome the strong rectilinear planar forces of the contacting roll surfaces under rotation, which are predominant and persistent in their guiding efforts toward misalignment as the strip is forwarded. The author would like to reiterate at this point that sufficient crown on conventional rolls cannot be utilized in contact with metallic strip, and that sufficient resilience in the metal strip is not available between two such successive rolls to secure sufficient variable temporary distortion in the strip from edge to edge within the elastic limit of the metal, under relatively high strip tension, to continuously and effectively overcome the powerful tendency to produce erratic tracking and overstraining of strip metal.

STEPS TO IMPROVE TRACKING

Summing up the conclusions and statements made in Items 1 to 8 inclusive as outlined above, it becomes apparent that continuous-bodied crowned rolls have very little power in themselves to maintain metal strip centered and in alignment on the center pass line of such rolls. With such crowned rolls, a constant change in temporary straining of the strip from edge to edge is taking place which represents the major factor in securing recentering and alignment.

From the conclusions reached it becomes evident that the positioning of the rotating roll planes at the surface of all types of rolls, together with the positioning of the longitudinal planes in the moving strip approaching and in arced contact with the roll surfaces, are all-powerful and alone determine the path that a continuous light gage metal strip section under tension will take in passing over a series of rolls consecutively without side guides. Guides have proven themselves detrimental to good operations when in contact with metal strip edges under tension.

It becomes evident, also, that automatic changes in positioning of the moving strip, or both, were the factors requiring investigation to improve tracking and aligning of the strip edges and centerline over a series of rolls or pulleys.

Because of the fact that the planar action at the surface of each rotating conventional roll, in a series of such rolls being utilized for forwarding continuous strip under tension, is rectilinear with all rotating roll planes in parallelism (but not necessarily completely parallel with those in adjacent consecutive rolls in the series), variable strip deformation from edge to edge is alone doing the work of recentering and aligning.

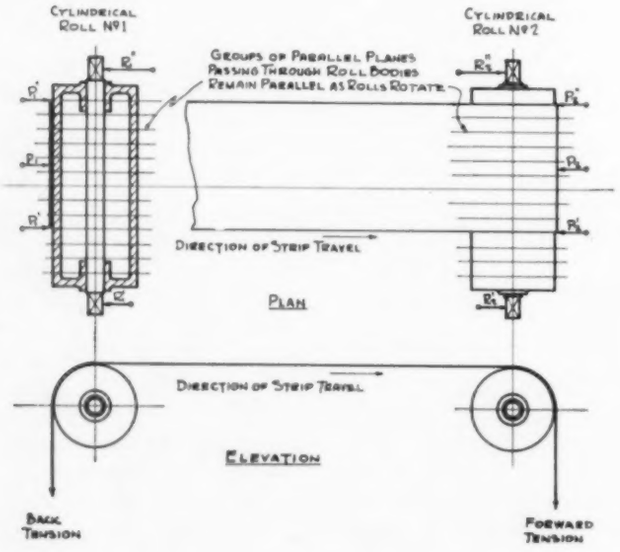
The high strip tensions now being employed to secure sufficient deformation in the strip to maintain fairly good tracking indicates that nothing further can be done with continuous-bodied rolls to improve this situation regardless of shell thickness or shape. In fact, the extent of this deformation should be reduced if at all possible by somehow providing automatic means for lowering strip tensions and at the same time for improving tracking more naturally to avoid the danger of over-straining the strip which at times results in edge waves, damaged strip and lack of strip flatness at the delivery end of processing lines or in metal strip conveyors.

The indications were that as a last resort, it would be necessary to somehow change the planar action of the deflector and conveyor rolls if the desired results were to be realized.

Desired results to be secured by improved tracking under reasonably lower strip tensions would:

1. Minimize operating hazards and increase safety.
2. Eliminate side guides if possible or minimize strip edge pressure against guides if they are absolutely necessary.
3. Increase production and prime product yields by minimizing strip damage and delays.
4. Minimize the rather great temporary and variable distortion now necessary in the metal strip or conveyor belt to secure relatively good tracking, thereby avoiding possible edge damage.
5. Reduce the average total tension presently required in the strip to a value more natural to secure good tracking, as little effort is normally necessary to shift light metal strip laterally into alignment under light tensions.
6. Reduce the crown effect in deflector and conveyor rolls and pulleys to secure more equal strip pressures from edge to edge in passing over such rolls.
7. Minimize the necessity for attempting to maintain rolls and pulleys in exact and precise alignment, one with the other, which is impossible.
8. Obviate the necessity of resorting to expensive deep looping pits for recentering in long processing lines.
9. Increase the life of the processing equipment and reduce maintenance cost by reducing wear and damage to equipment.
10. Reduce power costs for driving processing lines and conveyor belts.
11. Eventually contemplate the use of lighter and less costly line processing equipment for use in high

Figure 4 — Sketch illustrates the action of metal strip under tension when passing over uncrowned cylindrical rolls.



speed processing where the momentum and inertia values of heavy rotatable rolls and units associated with high strip tension are a hindrance rather than an asset in securing maximum processing efficiency.

DEVELOPMENT OF AUTOMATIC SELF-CENTERING ROLLS

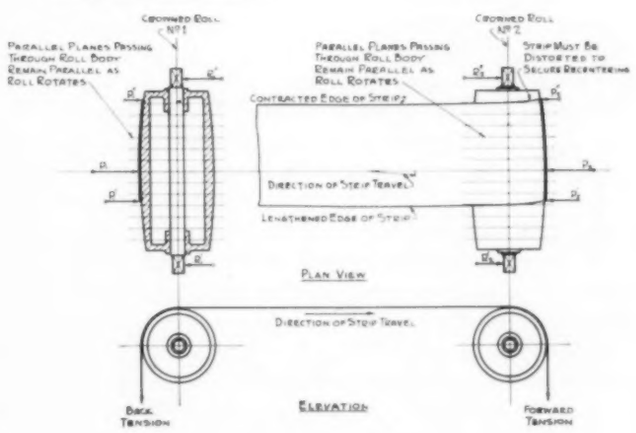
A further study of the planar action at the surfaces of the rolls indicated that the best possible means of securing the proper data for obtaining most of the desired results enumerated above would be to construct unconventional model rolls, for trial and experiment, in which the planes in each half of each roll rotating on or with a common axle or shaft would rotate slightly out of parallelism with the planes of the other half in a specific manner.

It had been determined, as mentioned previously, that the parallel planes perpendicular to the roll axes and intersecting rotating conventional rolls at their contacting surfaces, and those intersecting the contacting surface of the longitudinally moving strip arced over the rolls, always remain parallel and in exact alignment one with the other, creating a longitudinal moving parallel force combination so powerful that the rolls and contacting strip refuse to have their combination parallelism and alignment disturbed by external lateral forces applied to the strip. Only temporary or permanent distortion of the metal in the strip passing between and over such rolls can change the vertical positioning of the planes in the strip with respect to its edges, but all rotating roll planes in the arced section of strip passing over the rolls still remain in parallelism and in exact alignment one with the other, presenting a formidable force combination most difficult to deal with under reasonable low strip tensions, and resulting low surface pressures between moving strip and roll bodies.

If the rotating roll parallel planes in each half of each roll in a conveying system or processing line are thrown out of parallelism with those of the other half as mentioned above, then the two groups of parallel planes created in each roll rotate at definite angles on each side of the transverse vertical centerline of the roll in directions which are independent and out of alignment with each other. Such unconventional rolls, when properly constructed, not only have the ability to rotate on their common axis with their two groups of planes rotating at an angle with each other, but will each rotate at an angle with the parallel planes in the arced strip in contact with the roll in which strip the planes remain parallel over the full width.

Thus in this combination of rotating roll and arced strip in contact being forwarded, we have a system of conveying in which three separate groups of parallel planes are active, no single group of which can normally be parallel to either of the other two.

Figure 5 — The behavior of metal strip under tension when passing over crowned rolls is here shown in an exaggerated manner.


Crowned Roll No 1
Parallel Planes Passing Through Roll Body Remain Parallel as Roll Rotates
Crowned Roll No 2
Strip Must Be Distorted to Secure Recentering
Contracted Edge of Strip
Direction of Strip Travel
Lengthened Edge of Strip
Plan View
Direction of Strip Travel
Back Tension
Elevation
Forward Tension

FUNCTIONING OF AUTOMATIC SELF-CENTERING ROLLS

Thus the unconventional split double conical roll or pulley known as the automatic self-centering roll came into being, which, when used singly in connection with certain applications, or in series to form belted or processing line applications, has remarkable strip centering, tracking and aligning abilities for practically every kind of flat strip product being processed or utilized in conveyor belt systems, metallic or otherwise.

When rotating a series of these unconventional rolls with any and all types of objects to be conveyed by surface contact, natural strongly opposed lateral frictional forces, which have heretofore been hidden and unused, are released on the roll surfaces tending to move objects in contact toward the transverse roll centers into a position such that the center of gravity of the objects always remains on the center pass line while being forwarded, in which position the natural opposed lateral frictional forces are in constant balance.

When external forces utilized to displace objects from their pass line are released, objects again return to this pass line, and if the objects are sufficiently long and in contact with a sufficient number of the rolls, automatic alignment will take place as well as automatic centering.

Metal belts, or any type of belt for that matter, forming a closed circuit making repetitive cycles can be operated over self centering pulleys under any tension and linear speed with great exactness. Load distribution over the width of metal conveyor belts, for instance, will affect positioning of the belt on the pulleys for the reason that self-centering pulleys operate on the principle of centering combined cross-sectional center of gravity of the belt and live load being forwarded.

Continuous metal strip being forwarded over a series of self-centering rolls under tension in a processing line presents a somewhat different problem. If the strip is straight, no problem exists and the strip will remain centered and in alignment regardless of tension applied throughout the length of the line, if the rolls are reasonably maintained in parallelism and alignment. If, however, considerable camber or crookedness in the strip exists, then the pressure against the roll bodies becomes variable from edge to edge, which is of course, the same as changing the center of gravity of the cross-sectional area of the live load on the rolls. This will cause some movement laterally off the center pass line until the opposed lateral frictional forces released in the un-

conventional self-centering rolls become balanced. Means have been developed, however, in the construction of pivoted automatic self-centering pinch rolls, which, when properly utilized in continuous lines, will cause the strip under tension to vary little from the center pass line of the strip processing unit.

Metal strip processing lines equipped throughout with self-centering rolls and with pivoted automatic self-centering pinch rolls properly located in the line have the ability to dampen out errors in strip alignment as the strip proceeds through the line regardless of camber. In other words, off center strip at the entry end of processing lines so equipped will converge toward the center pass line as the strip proceeds through the line rather than continue to diverge from this pass line which is the tendency with conventional continuous bodied rolls in the line.

ACTION OF METAL STRIP IN CONTACT WITH ROLLS

Before proceeding with remarks on the construction of the unconventional split rolls, and the ultimate advantages to be gained in their use, it seems well at this point to present several drawings showing the action that takes place with the various types of rolls discussed in this paper when the rolls are rotated and the strip is forwarded over them.

Figure 4 shows two cylindrical rolls in parallelism and alignment, over which a length of straight metal strip is highly tensioned in an off center position and in an unrestricted manner. As the strip is forwarded, thereby rotating both rolls, the strip will continue to move laterally away from the pass line ultimately fouling its edge on the roll supporting frame work.

The reason for this lateral movement is as follows: Once the strip under tension is off center of the pass line, then the resultant mean contact pressures between rolls and strip are off center in the same direction. All forces applied to each roll must always seek an exact balance. Therefore, the reactive pressure at the roll bearings and support nearest the mean contact pressures between rolls and strip must increase while those on the opposite end must be reduced as the strip moves laterally. All materials in the assembly shown have resilience under load, strip, rolls, shafts, bearings, supporting structure, etc. The magnitude of deflection, linear extension and contraction, secured because of this resilience in any object, increase and decrease in proportion to the load applied and are variable within the object depending upon the load distribution and the location of the reactions resisting movement of the load.

The variable factors of deflection, linear extension and contraction in the materials which would be utilized to construct the supports and rolls subjected to high strip tensions may be very minute and practically infinitesimal as the strip moves laterally off center. A fraction of 0.001 in. differential in contraction and extension between R_1' R_2' and R_1'' R_2''—Figure 4, for instance, is sufficient movement (caused by the resilience in the bearing supports and framework) to throw both rolls 1 and 2 out of parallelism an unmeasurable amount, but sufficient to cause continued lateral movement of the strip away from the center pass line. In Figure 4, therefore, the relative planar action between the two rolls is always prone to change in accordance with the varying position of the strip, and since the low stretchability in the strip does not permit of sufficient temporary distortion on the approach side of the rolls to have the edges lie in planes exactly parallel or opposedly angled to those in the rotating rolls, no counteracting force is present to prevent the strip from continuing to move laterally away from the center pass line. The above is also true of flat belts operating over a pair of cylindrical pulleys.

Figure 5 shows two rather heavily crowned rolls in parallelism and alignment over which a length of straight metal strip is highly tensioned in a manner the same as in Figure 4.

All remarks and statements made above in connection with Figure 4 also apply to Figure 5 except those with reference to the strip and belt.

Crowning of the rolls does not change their planar action, and such rolls in themselves have no ability to center the strip other than to assist in securing realignment. Crowning does, however, permit temporary deformation and distortion in the strip in a proper manner to allow the strip to return itself to the center pass line.

When the strip is off the center pass line as shown in Figure 5, the edge farthest away from this line is contracted while the other edge is elongated. This action causes the vertical planes in which the strip edges lie at the approach side of the rolls to be angled sufficiently in the proper direction with respect to the rotating roll planes to cause the edges to move laterally back toward the pass line center.

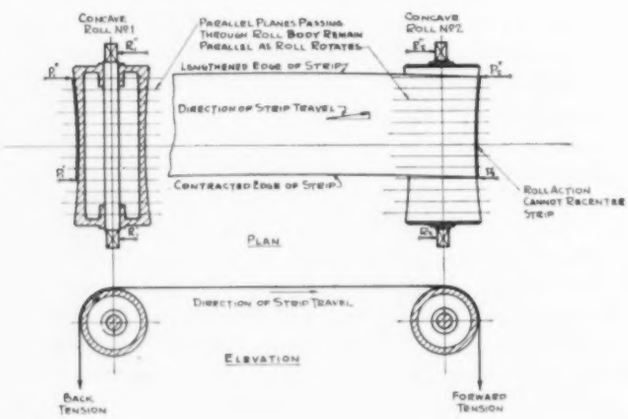
It should be recognized, however, that in actual practice sufficient crown cannot be made available to secure accurate tracking of steel strip at all times; that if adequate crowning were used, permanent distortion would at times be encountered.

For metal conveyor belts, sufficient crown to track them properly would result in permanent distortion transversely under high tensions and ultimate failure.

Figure 6 shows two concave rolls in parallelism and alignment, over which a straight metal strip is highly tensioned in a manner the same as in Figures 4 and 5.

All remarks and statements made above in connec-

Figure 6 — The behavior of metal strip under tension in passing over concaved rolls is here shown in an exaggerated manner.



tion with Figure 4 also apply to Figure 6 except those with reference to the strip and belt.

Concaving of the rolls does not change their planar action in that the strip is quickly distorted by moving off the center pass line rapidly in either direction, and will continue to move in the same lateral direction when once started until failure of one edge or the other takes place.

The reason for this unidirectional lateral movement is that the metal is constantly distorted laterally in the wrong direction by the tension applied, causing the edges of the strip to lie in vertical planes that are inclined with respect to the rotating roll planes in a manner opposite to those encountered when distorting the strip over crowned rolls.

Concavity caused by wear of continuous-bodied rolls in service must be watched carefully as a thousandth of an inch or two will tend to cause center repelling and misalignment of the strip under tension.

Metal belts cannot operate over conventional pulleys that have concave surfaces as the distortion in the belt caused by concavity in the rolls immediately causes repelling and misalignment in one direction or the other with respect to center pass line.

Figure 7 diagrammatically shows two unconventional split type automatic self-centering rolls in their simplest form, over which a section of straight metal strip is tensioned in an off center position similar to that in Figures 4, 5 and 6.

The reactions that take place between the strip and rolls under strip movement and roll rotation are far different from those outlined and shown in Figures 4, 5, and 6 where the reactions between strip and continuous-bodied conventional rolls are under consideration.

The conical effect for the rolls as shown in Figure 7 is greatly exaggerated for the sake of clarity in presentation. In actual practice, the conical or crowning effect required for the rolls can be as little as one sixtieth of that required for conventional crowned rolls.

Splitting of the rolls as shown unlocks pent up natural lateral forces in the rolls heretofore hidden and unused.

It has been mentioned previously that the rectilinear action of the conventional rotating roll planes at the contacting surface of the strip presents a formidible rectilinear force combination that refuses to be disturbed readily when the strip is under tension. The two groups of planes, one at the surface of the rolls and the other at the contacting surface of the strip, always insist upon remaining in exact parallelism and in exact alignment, thereby regulating the directional tendency or course that the strip takes in passing over the rolls regardless of the direction in which the strip edges will be forwarded, and which can be markedly out of alignment with the unidirectional planes in the arced section of strip passing over the rolls (see Figure 3).

In splitting the rolls as shown in Figure 7, three groups of parallel planes intersecting the roll and strip surfaces are immediately formed, no group of which can normally be in parallelism or alignment with either of the other groups when the strip is being forwarded in contact with the rotating rolls as explained previously in this paper.

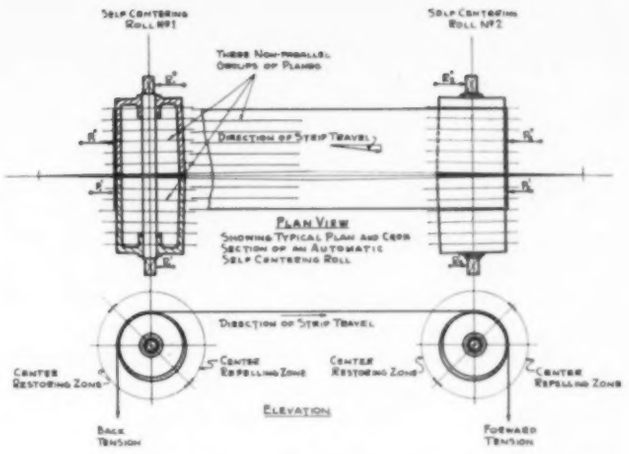


Figure 7 — The behavior of metal strip under tension when passing over automatic self-centering rolls is illustrated here.

Neglecting the functioning of the conical or crowning effect on the roll surfaces for the moment, each individual group of planes of the three in action has its particular function to perform in centering the strip on the center pass line of the rolls.

1. The parallel planes intersecting at the surface of one-half of the roll, on which the major portion of the strip rests, always causes the frictional force between roll surface and strip to simultaneously move the strip both longitudinally and laterally toward the center pass line of the two rolls.
2. The parallel planes intersecting the surface of the other half of the roll, on which the minor portion of the strip rests, tends to do likewise except that the lateral component of force is in the opposite direction and is of a smaller magnitude.
3. The unidirectional planes at the strip surface which is in frictional contact with the rolls at the initial line of contact; being parallel over the full width of the strip, regulate positioning of the strip edges on the approach side of the rolls relative to that of the center pass line.

With the strip off the center pass line as shown in Figure 7, and with a relatively light tension applied to the strip to secure motivation, the frictional forces between roll and strip surfaces on each side of the center pass line are obviously out of balance. As the strip moves forward and the rolls rotate, the half of the split roll normally exposed to the greatest frictional area of contact will move the center line of the strip laterally toward the center pass line until all frictional contact forces are in balance.

This balance of forces can only be satisfied when the edges of the strip become closely equidistant from the center pass line of the two rolls and when the strip becomes closely centered on that line.

There are factors such as camber, misalignment of rolls, concentrated localized tension in the body of the strip, unequal load distribution under tensions that are too low in conveyor belts, etc., which can upset the centering action somewhat, but the lateral frictional forces released by splitting the rolls as shown are constantly striving to center the strip or belt at all times to the best possible advantage.

In the above statements, the advantages of conical or crowning effect on the surface of the rolls has not been referred to as the author wished to bring out the fact that centering of the strip or belt can, with automatic self-centering rolls, be secured in a relatively satisfactory manner by means of the lateral frictional forces released in splitting the rolls.

Without the slight conical or crowning effect, the distance between the two end webs and roll body supporting hubs must normally be about 3 to 6 in. greater than the width of the metal strip or belt if relatively satisfactory centering is to be secured.

A slight conical effect on the surface of the rolls, far less than required with conventional rolls, is of advantage however as aligning and realigning of the strip or belt on the center pass line is more rapidly accomplished for a given strip speed even though the metal strip or belt overhangs the extremities of the roll body length. Tracking also becomes more stable in passing from one roll to the next and strip edge strains are minimized.

The relationship existing between the magnitude of strip deformation under tension, caused by providing a slight conical effect in each roll half, and the planar action at the surface of the split rolls, which releases the lateral components of frictional force to cause centering and tracking, is rather flexible and can be regulated in the design of such rolls for particular applications.

Optimum conditions can be incorporated in the strip passing over the conical roll surface well within the elastic limit of the metal at all times, particularly at the edges and center of the strip, where permanent deformation often takes place under high tensions when utilizing conventional rolls.

The small angularity required between the two non-parallel groups of planes at the surfaces of the two halves of the split roll to secure good centering and tracking also contribute to the optimum conditions mentioned above as leeway in design for this requirement is not at all critical.

For strip being continuously processed through lines equipped with automatic self-centering rolls, the angularity between the planes of both roll halves may be relatively great, say a portion of a degree, to secure required rapid recentering per foot of strip travel. For metal conveyor belts making many repetitive cycles in a given time, however, this angularity should be very small, perhaps a fraction of a minute, with a corresponding reduction in conical effect on the surface of the automatic self-centering pulleys utilized. In the latter case recentering is accomplished much more slowly, but when the metal conveyor belt finally reaches the center pass line of the two pulleys under rotation, which it will with self-centering pulleys, the belt will remain there and continue to complete cycle after cycle with no perceptible variation off the center pass line.

Very small angularities between the two non-parallel groups of planes at the surfaces of the two halves of split pulleys to be utilized in connection with conveyor belts should always be used with corresponding reduction in conical effect, so as to eliminate lateral belt deformation in passing repeatedly over each self-centering pulley. Under these conditions, metal conveyor belts will continue to track very well with an increased life far beyond that being secured with conventional pulleys.

Thus the principles of centering and aligning embodied in automatic self-centering rolls or pulleys lend themselves readily to a flexibility of design suitable for centering, aligning and tracking all types of flat products in the most satisfactory and efficient manner yet developed.

Figure 8 diagrammatically shows an elevation of two automatic self-centering pulleys over which a horizontal metal conveyor or power transmission belt is tensioned, which can be operated in either direction as desired with equal belt centering and aligning ability.

Under static conditions involving no longitudinal movement of the belt and no rotation of the pulleys, the initial tensioning of the belt, which need not be high, together with the weight of the pulleys and belt will deflect the pulleys downwardly and inwardly toward the axes of the pulleys a slight amount, until the line of minimum conical effect at the roll surface in contact with the belt assumes a definite position when all static forces applied to the system are in balance. For the belted system shown in Figure 8, this line of minimum conical effect always lies somewhere in a single quadrant of the pulleys cross-sectional area where the belt is in contact. For very low belt tensions under static conditions, this line lies at point A on either pulley, and as the belt tension is gradually increased to an extremely high value the line moves from points A to points B.

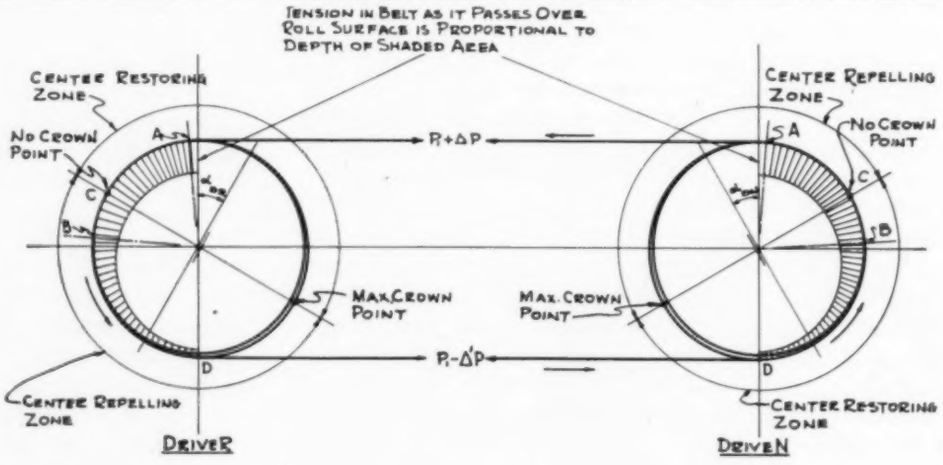


Figure 8 — Sketch illustrates behavior of automatic self-centering rolls when used for conveyor or transmission belt pulleys.

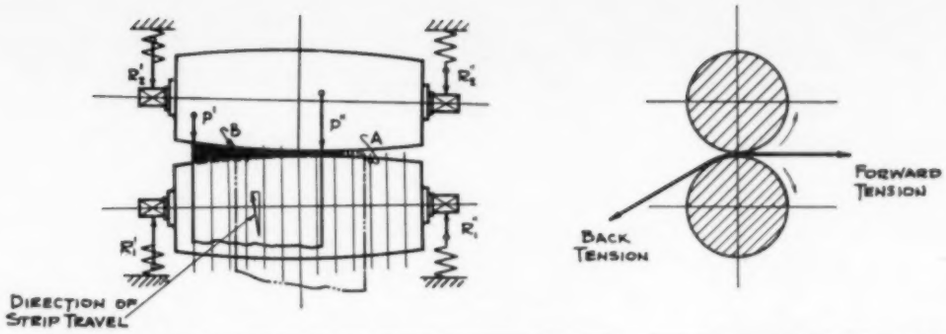


Figure 9 — The action of metal strip under tension when passing between spring loaded crowned cylindrical pinch rolls is illustrated in the sketch.

As motivation of the assembly begins in the direction shown, by power being applied to the driving pulley and the live load applied at the driven pulley, the line of minimum conical effect rises from point B to point C, the line of maximum conical effect assuming a position on the pulley surfaces diametrically opposite.

The position of points C on the surface of the pulleys is variable and always lies somewhere between points A and B. Point C always represents one extremity of the diametrical line at which the center-restoring zone of the pulleys at the surface begins or ends as shown in Figure 8. Conversely, C also represents the points at which the center-repelling zone, begins or ends.

The shaded areas shown in each pulley, the inner boundaries of which are not accurately developed or shown for the forces being applied to the system, represent the rate at which the tension in the strip is being reduced on the surface of the driving pulley as it is forwarded over this pulley by frictional contact, and the rate at which tension in the strip increases on the surface of the driven pulley as it rotates this pulley by frictional contact.

Point C will always lie on or closely adjacent to the radius line on which the center of gravity of the shaded area lies. If the position and shape of the shaded area changes because of a change in live load, then the position of points C change correspondingly. The position of the center restoring and repelling zones also changes in a corresponding manner as the position of points C changes.

In Figure 8 the metal belt approach to the driving pulley under reasonably high tension always contacts the pulley in the center restoring zone, where the crowning or conical effect is very low, being practically zero in actual practice. The conical effect decreases between points A and C and reaches zero at point C on the driving pulley. From C to B to D, the conical effect increases, but never reaches its maximum while the belt is in contact. Thus the belt in its most highly stressed condition when in operation is in contact with the driving pulley where the conical effect is always the least possible. The conical effect is greatest where the belt is least stressed while in contact.

As the return strand of the belt approaches the driven pulley in its least stressed condition, it contacts the pulley at D in the center-restoring zone where the conical effect is greatest, but not at the line of maximum convexity. As the stress in the belt gradually increases to a maximum at A, the conical effect from D to B to C becomes gradually less, reaching zero at point C. From C to A the conical effect increases slightly but remains very low.

If rotation of the system is reversed, with all other conditions remaining the same, points C will move downwardly into a position between B and D.

It should be recognized that Figure 8 shows the conical effect on the pulleys greatly exaggerated for clarity of presentation. In actual practice this effect need be but a few thousandths of an inch.

Thus, with automatic self-centering pulleys we have a belted system that may well prove to be more satisfactory for centering, tracking and aligning flat belts of all kinds than is possible with conventional crowned pulleys, and a system in which the material is more uniformly stressed over its entire width, resulting in less localized deformation which should lead to higher operating efficiencies and longer life of the equipment.

ADVERSE EFFECTS OF SPRING LOADED MOUNTINGS

Figures 9 and 10 show arrangements of pinch and deflector rolls or pulleys mounted in bearings with compression spring mountings in a relatively conventional manner, such that uniform pressure over the width of the strip or belt is expected to be obtained under all operating conditions.

Compression spring mountings, unless preloaded to prevent deflection under the total normal pressure required in operating are a detriment to the securing of good centering and aligning of strip-like materials over rolls or pulleys of all kinds.

Rolls or pulleys, with spring mountings at both journals in which the springs are free to expand or contract under a slight change in loading on either side of the pass line, always tilt the rolls with their planar action adversely when the edges of the strip or belt are not equidistant from this center pass line.

The distance from one strip edge passing over a roll to its nearest spring mounting, if greater than the distance from the other edge to its nearest mounting will, if the two mountings are under the same initial pressure, cause the strip edge furthest away to continue moving away and the other edge to move closer to the center pass line.

When passing metal strip over rolls that are free to be tilted slightly on spring mountings, each edge of the strip tends to act as an intermediate lateral floating fulcrum of a lever, the roll being a lever of fixed length with a spring at each end. The two lateral floating fulcrums, being represented by the two strip edges, remain equidistant with respect to the two ends of the lever represented by the fixed length of the roll.

Under static conditions, with the centerline of the strip on the center pass line of the roll, and with equal pressure applied to the rolls to secure approximate

equalized pressure over the width of the strip, all forces are in static balance.

As the strip is forwarded and the rolls are rotated, however, the forces must change in an attempt to secure equalization or balance of these forces under running conditions. This is most difficult and practically impossible to accomplish with spring mountings at each end of the roll or rotating lever. Lateral movement of the strip edges (floating fulcrums) in the proper direction would alone correct this balance. Unfortunately the force system, when utilizing springs as force reactions, is not constituted so as to permit this to happen.

Because of the simultaneous lateral movement of both metal strip edges off the center pass line, the balance of the static forces becomes immediately upset and impotent for center restoring under running conditions.

A lateral movement off the center pass line as shown in Figure 9 for instance, increases the rotating lever arm length from $R_1''A$ to $R_1''P''$ which reduces the pressure at R_1'' slightly, but increases the pressure at the floating fulcrum P'' quite markedly. Conversely, since both edges of the strip move simultaneously the same amount and in the same direction, rotating lever arm length $R_1'B$ is shortened to $R_1'P'$, which increases the pressure at R_1' slightly but reduces the pressure at the floating fulcrum P' quite markedly.

This action of the forces involved causes the roll or rotating lever to tilt away from fulcrum P' slightly and toward P''. This action also causes the vertical rotating roll planes intersecting the roll surface to tilt in the same direction, which creates center repelling of the cross-sectional area of the strip as it contacts the rolls on the approach side. In other words, the planar action of the rolls in their tilted position is non-restoring of the strip edges as indicated in Figure 9.

For pinch rolls with one roll in fixed mountings and the other in spring mountings, the action outlined above remains the same with the result that when once the metal strip is off the center pass line, the forces involved can never be automatically rebalanced without manipulation of reactive pressures R_2' and R_2'' and R_1'' manually or by electrical means such as photo-electric cells, etc.

The reactions outlined above are applicable to conveyor or metal strip deflector rolls with spring mountings as shown in Figure 10.

Spring mountings free to expand or contract for rolls in contact with metal in conveying, processing or belted systems should, therefore, never be utilized if their use can possibly be avoided for reason of their highly detrimental effect on tracking. If they must be used as shock absorbers or as take-ups, they should either be preloaded, so as to be inactive under normal operating strip tensions, or the mountings should be equipped with long sliding guide members to cause both ends of the rolls to move in unison exactly the same amount if possible and in the same direction.

Independently acting counterweights or compressed air and hydraulic cylinders replacing spring mountings on each end of the rolls, to apply pressure on moving strip, rotating coils, and the like are fully as detrimental to tracking of such materials as spring mountings free to expand or contract. They should never be utilized if their use can possibly be avoided.

With a spring mounting, free to expand and contract, at one end of a conveyor or deflector roll and with the other end in a fixed mounting to retain its position constantly, tracking of the strip over the roll can be secured with auxiliary mechanisms to vary the tension in the strip approaching and passing over the roll. This involves the use of photo-electric cell equipment, however, to alternately reduce and increase the strip tension slightly. This action tilts the roll and its intersecting rotating roll planes in the proper direction with respect to those in which the strip edges lie to effect recentering.

The arrangement outlined above will, of course, cause the roll to "dance" continually while the strip is being forwarded and will cause the electrical strip speed control to react constantly according to the dictates of the photo-electric cell. This will effect recentering by varying the strip tension up and down rather rapidly, to secure the necessary weaving of the strip edges from side to side of the center pass line.

CONSTRUCTION OF AUTOMATIC SELF-CENTERING ROLLS

Split automatic self-centering rolls and pulleys can be constructed in many different ways, as determined from many model experimental rolls. Such rolls and pulleys can be constructed so that they are either unidirectional or reversible in their operation so far as centering and aligning is concerned.

For some specific applications, the unidirectional type is recommended, whereas for most applications the re-

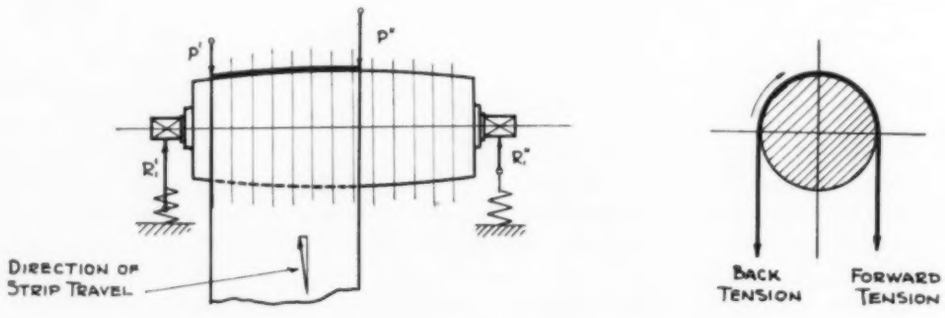


Figure 10 — The action of metal strip under tension when passing over a spring supported crowned cylindrical roll is shown in this sketch.

versible type can be used to better advantage. In any case the roll or pulley must be split at the transverse center line of the assembly as indicated in Figures 7 and 8. Figure 7 shows the simplest form and type of construction for an automatic self centering roll that can be operated equally well in either direction, and can be made suitable for most applications.

Questions will arise as to the initial cost, maintenance and life of split rolls and pulleys as compared with conventional continuous-bodied units presently being used.

The initial cost of the rolls themselves may be somewhat higher but the advantages to be gained in securing reliable tracking of strip and belts of all kinds, with the elimination of side guides and auxiliary guiding mechanisms in many many instances, should materially reduce the initial overall cost of the equipment required to do a particular job.

Maintenance of the split automatic self centering rolls themselves should be less than for conventional rolls for two very important reasons; first, automatic centering and good tracking of strip-like material can be secured under far less strip tension than presently required, and second the crowning or conical effect on rolls, so necessary to secure adequate tracking of strip-like material over the rolls, can never be totally destroyed by wear on automatic self centering rolls while in operation. These two factors indicate that less wear on roll bearings, roll surfaces, etc., will be encountered, resulting in many more hours of service before the rolls must be removed for regrinding and repair.

The life of split automatic self centering rolls should be greatly increased as compared with conventional continuous-bodied rolls for the reason that they require little if any regrinding of the roll surfaces to remain effectively operative during their life. The design can be such that the slight deflection in the roll surface required to center and align strip-like material properly will create stresses and strains in the rolls and shafts that are no greater than caused by the combined bending and shearing stresses and strains in the rotating shafts of conventional rolls immediately adjacent the roll body ends and shaft journals (usually the critical point of stress and strain in conventional rolls).

The ability of split automatic self centering rolls and pulleys to improve centering and aligning of strip-like materials is so great, as compared with that of conventional continuous bodied rolls, that their use should be carefully considered in any plans for new strip processing lines, belt conveyors or belted power transmission systems.

APPLICATIONS OF SPLIT AUTOMATIC SELF-CENTERING ROLLS

Experiments with working models of various types of equipment utilizing split automatic self centering rolls indicate that the benefits to be secured as outlined heretofore in this paper can be realized.

Small diameter model automatic self centering rolls have been operated at rotative speeds of 10,000 rpm without difficulty. A model belted system consisting of two 5-in. diameter centering pulleys and light gage stainless steel belt, 0.005-in. thick, also a light gage paper belt, were operated with the pulleys rotating at about 5,300 rpm with the belts travelling at 6,800 fpm. Excellent tracking was secured and the belts always returned to the center pass line when forced off center on either side. High or low tensions made no material difference in tracking ability.

Full scale split rolls and pulleys of the self centering type have been in operation in commercial processing lines for several months. The results reported are very good, indicating that the rolls and pulleys function in accordance with the experimental findings.

Several full scale split automatic self centering rolls are at present being constructed for various companies at Carnegie-Illinois Steel Corp.'s Johnstown works for use in experimental full scale metal strip conveyors and metal strip processing lines. Many other installations of automatic self centering rolls are at present being contemplated throughout the country.

The development and use of split automatic centering rolls is not limited to the iron and steel producing industry alone. Practically every industry, where driven conveyor and idler rolls and pulleys are utilized for forwarding strip-like materials in a definite path, should find economic advantages in the utilization of automatic self-centering rolls.

In closing, the author would like to repeat that in the utilization of split automatic self centering rolls for power transmission systems, belt conveyors, roller conveyors, strip processing lines, etc., the investment is relatively small but the savings may be very great. Also, to issue a note of warning, beware of spring, counterweighted, hydraulic or air cylinder journal mountings free to function independently for all types of rolls and pulleys to be utilized for conveying or forwarding metal strip under tension through high speed processing lines. Rotating rolls with such mountings (when subjected to pressure by the strip being forwarded, or utilized for creating pressure against the moving strip or object, such as a rotating coil of metal strip being unreeled into a continuous pickler, for instance), can cause the strip or coil to immediately leave the center pass line with a rapidity that is astounding. The damage of strip or coil edges from resulting contact with side guides can be avoided by the elimination of springs or counterweights, etc., and by employment of automatic self centering rolls with rigidly mounted journals, operating under normal strip tensions and roll body pressures.

ACKNOWLEDGMENTS

In closing, the author wishes to thank the Research Laboratory of Carnegie-Illinois Steel Corp. and William H. Mursch of the Senior Staff Engineering Bureau of Carnegie-Illinois Steel Corp. for their full cooperation and unstinting service in constructing the model equipment for experimental purposes, the results of which have made this paper possible. The author also wishes to express his appreciation of the assistance given by Howard S. Orr and Alfred Teplitz in experimental work, and in recording the results secured, which are embodied in this paper.

A PROGRESS REPORT

on Carbon in Blast Furnaces

BY T. J. ESS

. . . . as a blast furnace refractory, carbon is still a newcomer in American practice . . . . perhaps its virtues and its failures have both been over-emphasized . . . . this review of progress indicates that the answer will come from the experience of the next few years . . . .

▲ AS a blast furnace refractory in the United States, carbon is a development of only the last decade. The European history of carbon in this application, however, dates back some 65 years, when a report was made on the use of blocks of carbon (made of retort carbon and tar, baked) as hearth and bottom blocks in a German furnace producing ferro-manganese. Over the ensuing years, many European operators experimented with carbon in various forms and in various applications. A number of reports made around 1912 on this experimentation show mixed results, and indeed, contain many of the same conclusions and raise many of the same questions that are current in American applications today.

Experience and the development of better grades of carbon led to increasingly better results, and by 1940 approximately 75 per cent of the German blast furnaces used carbon linings in the lower sections, and the practice had spread into other European countries and into England.

Three types of carbon construction have appeared in the evolution of the application: rammed carbon paste, carbon brick in standard sizes and large carbon blocks, and each has found its proponents. In the first of these, European practice uses a paste made of five to six parts of coke and one part tar or tar-pitch mixture. The coke, which should be of a good grade, with ash as low as possible, and thoroughly dry, is ground to pass through an 0.039-in. screen. The tar should also be free of water. The materials are heated to 250–300 F and thoroughly mixed.

The paste is then rammed in place in layers 1½–2 in. thick, using hot metal rammers, as the temperature of the paste must be kept fairly even through mixing and ramming. In European practice, a solid hearth five to seven feet thick might be built up and the carbon paste carried on up the walls to various heights, most of the German furnaces using it up to the mantle. Although carbon paste linings have shown some fine operating records in Europe, they are not used at present in the United States. It is now felt that carbon paste is not a particularly good refractory until it is properly fired, and the conditions for firing it inside a blast furnace are not good. It is also believed that cracking occurs in the large masses formed in the rammed lining while it is changing from a plastic state into a solid state.

The use of preformed carbon started with standard brick sizes, and gradually progressed to larger and larger blocks, until today sizes up to 7000 lb are used. This type of construction will subsequently be discussed in more detail.

EXPERIENCE IN ENGLAND

Perhaps the most extensive experimentation with carbon in blast furnaces has been in England at the Appleby-Frodingham plant of United Steel Companies, Ltd., and this experience was given by G. D. Elliott, manager of blast furnaces, in a paper before the joint meeting of the Blast Furnace and Coke Association of the Chicago District and the Eastern States Blast Furnace and Coke Oven Association in Detroit, Mich., in October, 1949. This plant had installed ten carbon hearths, four carbon boshes, one belt of carbon in the stack inwall and two (now three) all-carbon furnaces (from hearth to stock-line), and considerable research was devoted to the applications. Carbon was adopted primarily to prevent breakouts and salamanders.

Some of the conclusions reached through these experiments follow:

Air and water vapor must be kept out of the carbon-lined furnace, as they increase the porosity of carbon.

Carbon has some after-shrinkage (probably 17–20 per cent of that of fire brick) which can be prevented by cooling. Firebrick between the carbon and the cooling medium hinders cooling, and is therefore undesirable.

Wall construction must be kept virtually independent of the bottom. Hence, side walls should be continued right down to foundation level, enclosing the bottom.

No material has been found that will bind to carbon. Hence, joining material is of no avail if after-contraction occurs.

Joints should be kept as tight as possible, rather than depend on rammed joints.

Depth of carbon bottom should be sufficient to guarantee mechanical stability, to keep the underlying fire brick from softening, and to permit iron penetrating the joints to solidify before reaching the bottom of the carbon.

Carbon tap holes are not used because of the danger of air getting to them during casting, as it is not always possible to avoid blowing through the taphole. Also, steam may originate from the stopping mixture.

A carbon brick may become saturated with alkali salts, but no reaction takes place. Also, no carbon deposition occurs.

Carbon-lined boshes, first installed in 1945, keep cleaner than firebrick boshes, show virtually no wear, and give smoother furnace operation. In laboratory work, iron ores could not be made to stick to carbon.

Comparative tests showed carbon brick to be more resistant to mechanical abrasion than the fire brick normally used for stack lining.

No scaffolds were formed on a 15-ft belt of carbon built into a furnace lining about 40 ft above the tuyeres, and the carbon remained intact for more than two years.

From this experience has evolved a carbon lining design which Mr. Elliott feels will be satisfactory. The fire brick foundation is topped with $\frac{1}{16}$ in. steel sheets, upon which is put a layer of aluminous cement one or two inches thick. On this, the carbon floor is built to a depth of 5 or 6 ft. The bottom construction uses patented corrugated carbon blocks (Figure 1) in about four courses, interlocked in depth. The blocks are laid dry, and as close as possible, using no jointing cement and no ramming except in the small make-up areas (less than $\frac{1}{2}$ brick in size) at the periphery of the hearth. The tap-hole is kept at least $2\frac{1}{2}$ ft above the top of the carbon.

The carbon wall, which is carried down to the fire brick foundation so as to enclose the bottom pad (in American installations, the carbon walls usually set upon the carbon hearth pad), is about $22\frac{1}{2}$ in. thick and is built of small, standard shapes, flush against the hearth cooling staves. No provisions are made for expansion. On the outside of the staves is a 2-in. rammed layer of carbon paste, and then a 7-in. carbon brick wall, all encased in a steel plate jacket which is provided with emergency shower cooling. The layer of carbon around the outside of the hearth staves is a protective feature, and has been patented by United Steel Companies, Ltd. (It is now believed that this extra precaution is unnecessary.) Around the tuyere belt, which is not plated, the carbon wall is sparsely cooled with cooling plates.

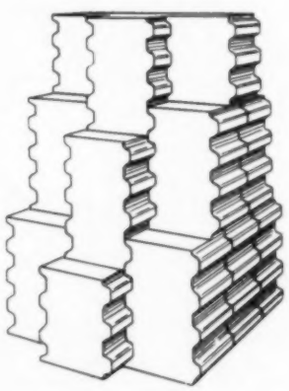


Figure 1 — This corrugated carbon block design, interlocked throughout, has been used in the later hearths at Appleby-Frodingham works of United Steel Companies, Ltd.

Tap holes are constructed of fire brick, allowing 14 in. of fire brick between the hole and the carbon lining.

Based on the excellent performance of a $13\frac{1}{2}$-in. carbon bosh lining, the more recent bosh linings are constructed with a single 9 in. course of carbon brick, shower cooled.

Above the mantle, carbon brick is used to form a lining which starts with a thickness of $22\frac{1}{2}$ in. and increases to 3 ft near the stock line. On the first all-carbon stack, coke-tar mixture was rammed between the carbon wall and the shell for insulation and for cushioning, but the tar ran down when it became hot, forming an insulation at the top and a conductor at the bottom, necessitating the use of shower cooling on the stack. In the second all-carbon furnace, vermiculite brick was placed next to the carbon wall, with loose vermiculite next to the shell.

In the stockline section, the conventional construction with fire brick and wearing plates was retained.

By using an all-carbon lining in the two furnaces previously mentioned, it was possible to enlarge the furnace somewhat, due to the thinner linings. Construction was simplified through the use of shower cooling instead of cooling plates. Mr. Elliott expects these furnaces (one blown in early in 1949, the other near the end of 1949) to maintain cleaner lines and to have a greatly increased life. He states: "There is no insoluble refractories problem connected with the use of carbon in the furnace hearth and bosh. Without advocating the use of carbon elsewhere, I believe there is sometimes a case for the use of carbon in the stack and that the refractories problems connected with the use of carbon in the stack are not serious."

Since Mr. Elliott's paper, a third all-carbon furnace was blown in at Appleby-Frodingham, somewhat similar to the second installation. After 15 weeks of operation, a break-out occurred at the bottom of the hearth jacket, more than 5 ft below tap hole level. Externally, the breakout showed up as a hole about $1\frac{1}{2}$ in. in diameter between the two bottom courses of carbon wall brick. Investigation showed this hole to lead to a cavity about 18 in. × 12 in. × 5 in. in the fire brick and concrete below the carbon hearth pad. Due to peculiarities of the old foundation, the carbon hearth in this furnace had been modified considerably from the regular design and had a depth of only 35 in. instead of the regular 60 in. or more. The hearth jacket of the furnace is only 9 ft 4 in. overall in height. The company's examination indicated that there was insufficient hearth carbon to chill metal penetrating along the joints.

The section cut out during the investigation was filled in with carbon brick and carbon paste in which cooling pipes were inserted. The furnace went back into operation after an outrage of 38 hours and has since operated in a normal manner.

EXPERIENCE IN THE UNITED STATES

What was perhaps the first experiment of carbon as a blast furnace refractory in the United States was reported by James Gayley (Transactions AIME, Vol. XXI, 1892-1893). This paper tells of the use of carbon

TABLE I

Chronology of Blast Furnace Carbon Installations

	1945	1946	1947	1948	1949	1950 (First half)	Total
Carbon hearth pad only	2	0	1	2	1	1	7
Carbon hearth, single carbon wall with firebrick outside	1	1	0	7	1	1	11
Carbon hearth, single carbon wall with firebrick inside	1	2	0	0	0	0	3
Carbon hearth, single carbon wall	0	0	2	1	0	0	3
Carbon hearth, double carbon wall	0	6	11	23	10	3	53
	4	9	14	33	12	5	77

brick in furnace A at Braddock. The hearth bottom was built up of brick made of graphite and clay, while hearth and bosh walls were built of two types of brick made from coke and clay and from coke and tar. The carbon lining extended 12 ft above the tuyeres. The furnace had just been put into operation when the paper was read but Gayley felt that, while carbon would be serviceable in the hearth, its greatest value would be in the bosh, where it would work to give smooth furnace operation.

The only other available information on this installation (Transactions AIME, Vol. XXVI, 1896) states that furnace A was still operating with satisfactory results.

In recent years in the United States the use of carbon as a blast furnace lining started cautiously with some carbon patches and in 1937 carbon paste was tried in one furnace, but applications lagged until about 1943, when the wartime drive for more iron production stimulated interest in carbon. In 1945, four furnaces were blown in with carbon in the hearth construction. Two of these had only hearth floors of carbon, while the other two also had carbon walls up to the vicinity of the cinder notch or the top of the hearth cooling staves. (Table I).

In 1946, nine furnaces were blown in with carbon floors and walls of varying designs in the hearths, and 1947 brought 14 more. A peak was reached in 1948, when 33 furnaces in which carbon was incorporated were blown in. Twelve new installations were put into operation during 1949 and five more were put in during the first part of 1950. In addition, about ten carbon hearth linings have been made but for various reasons have not yet been installed.

An example of hearth pad installation may be found in the Warren furnace of Republic Steel Corp. (Figure 2). A single carbon pad 30 in. thick was put into this 27-ft furnace, with the top of the carbon 4 ft 8 in. below the center line of the iron notch. The carbon blocks were 24 in. × 30 in., with lengths varying up to a maximum of 15 ft. A total of 32 pieces were used, with

Figure 2 — The Warren furnace of Republic Steel Corp. has a single course carbon hearth pad.

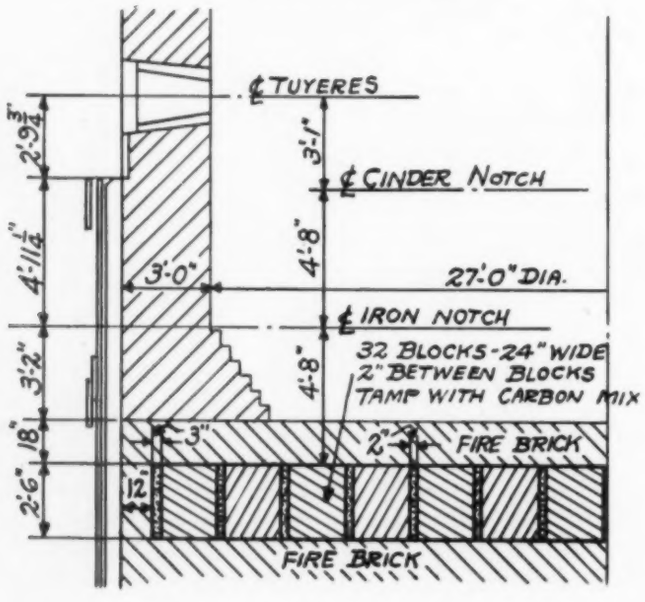


Figure 3 — Carrie No. 1 furnace at Homestead works of Carnegie-Illinois Steel Corp. has carbon hearth and walls constructed of relatively small carbon block, with ceramic material inside.

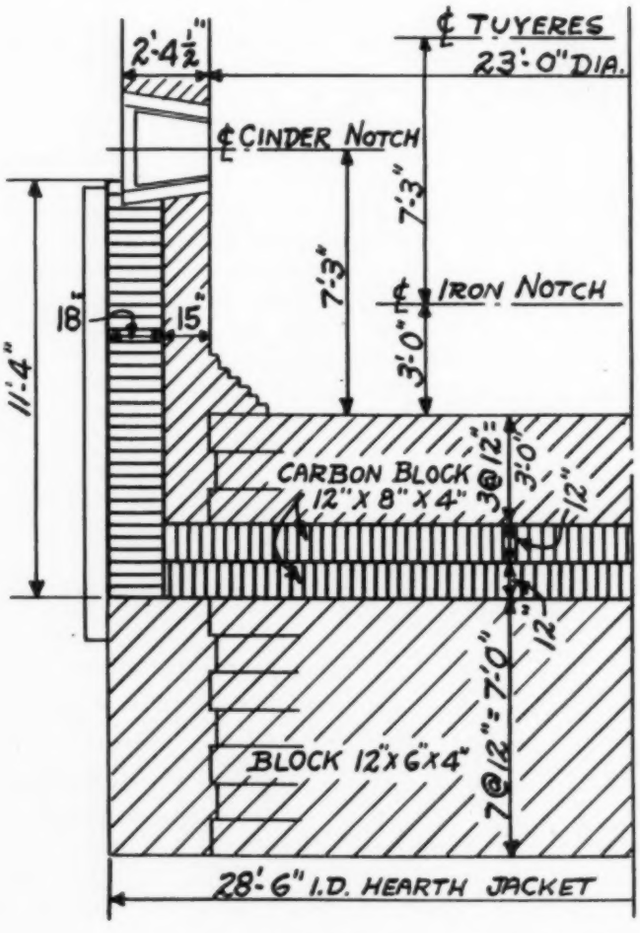


TABLE II
Tabulation of Carbon-Lined Blast Furnaces

Company	Plant	Furnace	Hearth diam, ft-in.	Carbon thickness, in.				Bottom to center line of iron notch, ft-in.	Type of iron notch	Date blown in	Date off
				Bottom		Sidewall					
				Upper	Lower	Inside	Outside				
American Steel & Wire Co.	Donora	1	19-0	22½	22½	†11¾	11¾	3-7	C	1/49	9/49
Armco Steel Corp.	Ashland		27-3	22½	22½	15	15	4-3	C	7/49	
	Hamilton	2	18-0	22½	22½	11¾	11¾	3-11	C	4/48	
Bethlehem Steel Co.	Bethlehem	C	27-2	22½	22½	15	11¾	5-5½	C**	4/47	6/49
	Bethlehem	E	19-0	22½	22½	15	11¾	3-10	FB	3/46	12/49
	Johnstown	K	21-0	22½	22½	15	9⅞	5-0	C	5/49	6/49
	Sparrows Pt.	A	24-6	22½	22½	13	11¾	5-0	C	6/48	
	Sparrows Pt.	B	24-6	22½	22½	13	11¾	5-0	C	6/48	
	Sparrows Pt.	F	19-9	22½	22½	15	12	5-0	C	3/49	
	Steelton	A	19-6	22½	22½	11¾	11¾	5-3	C	7/48	
	Steelton	E	19-6	22½	22½	11¾	11¾	5-3	C	4/49	
	Lackawanna	A	21-3	28½	28½	15	11¾	5-0	C	7/49	
	Lackawanna	B	20-6	22½	22½	15	12	5-0	C	6/48	
	Lackawanna	H	27-0	22½	22½	15	12	5-3	C	12/48	
Brazilian National Steel Co.	Volta Redonda		25-0	28½	28½	15	15	3-3	FB	1/50	
Carnegie-Illinois Steel Corp.	Braddock	4	19-3	22½			†	2-9	FB	5/48	6/49
	Braddock	5	25-0	22½			†	3-6	FB	10/48	6/49
	Braddock	6	23-6	22½	22½	15	15	5-1½	C	10/47	
	Clairton	1	23-0	22½	22½	15	11¾	5-0	C	10/48	
	Clairton	2	18-6	22½	22½	15	11¾	4-6	C	4/49	
	Etna	1	17-0	9	9			1-10½	FB	6/47	
	Rankin	1	23-0	12	12	15*	18	6-0	FB	12/45	
	Rankin	3	26-0	22½	22½	15	15	5-0	C	1/49	
	Rankin	6	23-6	23	13½	11¾	11¾	4-6	FB	11/46	
	Rankin	7	23-6	12	12	15*	18	6-0	FB	7/46	
	Youngstown	2	25-0	22½	22½	15	11¾	3-3	C	4/48	
	Youngstown	4	23-0	22½	22½	15	11¾	3-3	FB	11/47	
	Gary	5	20-6	22½	22½	11¾	11¾	4-0	C	2/49	
	Gary	6	28-0	22½	22½	15	11¾	4-0	FB	7/47	
	Gary	8	25-6	22½	22½	11¾	11¾	4-0	C	2/48	
	South	5	23-0	24	12			4-0	FB	9/45	
	South	11	28-0	22½	22½	15	11¾	5-0	C	4/48	
	South	12	28-0	22½	22½	15	11¾	5-0	C	6/48	
Chester Furnace Co.	Chester		15-9	18		12	*	3-0	FB	1/49	5/49
Colorado Fuel & Iron Corp.	Pueblo	E	20-6	22½	22½	15	15	2-8	FB	10/46	
Dominion Steel & Coal Corp., Ltd.	Sydney	1	18-6	22½	22½	11¾	11¾	4-0	C	1/48	
	Sydney	3	19-3	22½	22½	15	15	4-6	C	4/48	
Cia de Fomento de la Producion	Concepcion, Chile	1	20-9	13½	13½	15	15	4-0	C	6/50	
Ford Motor Co.	Dearborn	B	18-6	22½	22½	15	15	3-6	FB	11/49	
	Dearborn	C	27-6	22½	22½	18	18	4-6	C	11/48	
Great Lakes Steel Corp.	Detroit	A	17-9	22½	22½	13	11¾	3-6	C	12/48	
	Detroit	B	27-3	22½	22½	15	15	3-6	C	9/47	
Inland Steel Co.	Indiana Harbor	6	25-9	22½	22½	13½	11¾	4-3	C	7/48	
Interlake Iron Co.	Chicago	A	17-0	30		15	10½*	4-0	C**	12/48	7/49
	Chicago	B	19-4	30		23¼	9*	4-0	C & FB	2/48	
	Duluth		14-0	24		12	19½*	2-3	FB	11/45	
	Erie		15-7	30		15	7½*	4-0	C & FB	4/48	
	Toledo	A	19-0	30		15	14½*	4-0	C & FB	9/48	
Jones & Laughlin Steel Corp.	Pittsburgh	1	18-8	22½	22½	11¾	11¾	4-0	C	2/48	6/49
	Aliquippa	3	28-6	22½		12	27*	6-0	C	8/48	10/48
Koppers	Granite City	B	19-6	28½		15	17½	3-3	C	11/48	
Lone Star Steel Co.	Daingerfield	1	27-0	22½	22½	11¾	11¾	4-8	C	9/48	
National Tube Co.	Lorain	1	23-0	30	15	13½	11¾	2-11	C	2/48	
	Lorain	3	26-0	12	12	41*	18	5-3	C	2/46	
	Lorain	4	26-0	30	15	11¾	11¾	3-2	C	7/48	12/48
	Lorain	5	22-3	30	15	15	12	4-5	C	8/46	
	McKeesport	4	22-5	22½	22½	15	15	3-11	FB	7/47	
Pittsburgh Coke & Chemical Co.	Neville Island		22-0	12	30			3-6	FB	7/50	
Pittsburgh Steel Co.	Monessen	1	19-0	22½	22½	15	10⅜	3-6	C	2/47	4/49
Republic Steel Corp.	Buffalo	1	19-0	22½	22½	15	9-19	4-0	C**	8/47	8/49
	Buffalo	2	21-11	22½	22½	10⅜	12-24	4-3	C**	11/46	12/48
	Canton		18-3	22½	22½	24		3-6	C	5/48	
	Cleveland	1	25-9	23¼	22½	30		4-5	C**	1/47	12/49
	Cleveland	2	17-0	22½	22½	30		4-6	C**	9/47	6/49
	Cleveland	3	17-3	23¼	22½	24	8¼*	4-6	FB	5/50	
	Warren		27-0	30				4-8	FB	11/45	
	Youngstown	2	23-9	22½	22½	15	15	3-9	C	12/46	
	Youngstown	3	25-6	29½		15	13½*	4-9	C	6/46	
	Youngstown	4	17-9	22½	29¼	24	4½*	4-1	FB	5/50	
	Youngstown	5	19-0	22½	22½	15	11¾	4-2	C**	3/47	4/49
Tennssee Coal, Iron & Railroad Co.	Ensley	1	22-0	22½	22½	11¾	11-15	3-9	C	10/47	
	Ensley	2	22-6	22½	22½	11¾	11-15	3-9	C	5/48	
	Fairfield	7	27-3	22½	22½			4-6	FB	4/49	
Weirton Steel Co.	Weirton	2	25-6	22½	22½	11¾	16-22	5-0	C	4/47	
	Weirton	3	25-6	22½	22½	11¾	16-22	5-0	C	11/48	
Youngstown Sheet & Tube Co.	Briar Hill		18-6	30		15	15*	3-6	C & FB	5/48	
	Indiana Harbor	1	26-0	30		27	9*	4-0	C	9/48	

*Firebrick or other ceramic.
†Carbon breastwall 2 ft-8 in. thick extends 7½ ft on each side of tap hole, and vertically from pad to top of hearth staves.
**Carbon iron notch has been changed to firebrick.

2-in. joints allowed on all faces and filled with rammed carbonaceous paste. To take care of expected expansion, additional rammed material was placed at the outside periphery of the pad so that the total thickness of rammed material in all joints was 14 in. along the length of the blocks and 20 in. across their width.

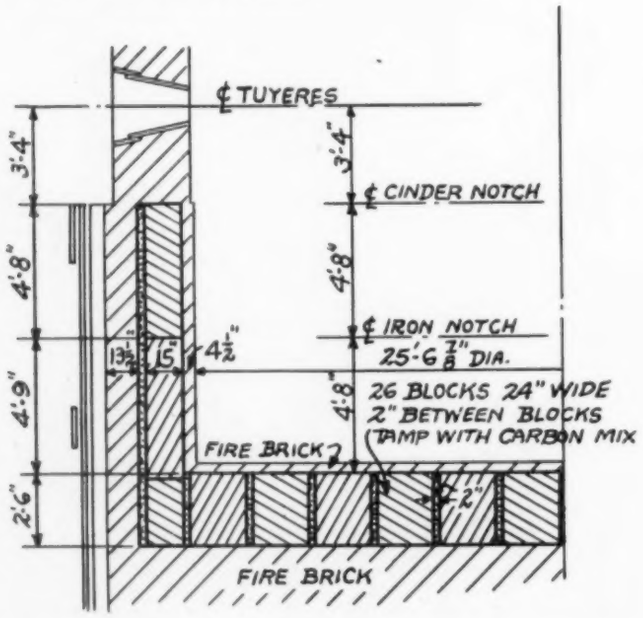
This furnace is still running after more than 4½ years operation and a production of over 2,100,000 tons of iron, but a relining is now planned which will include a complete carbon hearth.

An application of carbon in small block or brick sizes is typified by Carrie No. 1 furnace at the Homestead plant of Carnegie-Illinois Steel Corp. (Figure 3). The hearth of this 23-ft unit was built up with two courses of 12 in. × 8 in. × 4 in. carbon brick laid on end so that the top of the carbon was 6 ft below the center line of the iron notch. An 18 in. thick carbon wall, of 18 in. × 11 in. × 4 in. straights and keys, was built tight to a vertical height of 11 ft 3 in., starting at the bottom of the carbon hearth pad (8 ft below the iron notch) and extending to the top of the hearth staves.

Within this carbon shell, a 13-in. fire brick wall was installed, and three 12-in. courses of fire brick were laid over the top of the carbon bottom. The iron notch section was constructed of specially shaped fire brick. This furnace has been in operation over 4½ years and has produced more than 1,200,000 tons of iron. However, American opinion does not favor the use of the small sizes of carbon, although some blast furnace men feel that side wall blocks should not be larger than about 18 in. in length.

As an example of carbon lining with fire brick backing up the sidewalls, Republic's Youngstown No. 3 furnace, (Figure 4) a 25 ft 6 in. unit, has a 30-in. bottom pad composed of 26 pieces and installed in a similar manner to the Warren hearth described above. The sidewall is composed of carbon block. In the section around the iron notch, carbon extends from the inside outward to the hearth jacket. The remainder of the wall is made up of 15 in. of carbon block backed up by 13½ in. of fire

Figure 4 — Republic's No. 3 furnace at Youngstown combines an inner carbon course and an outer ceramic course in the side walls.



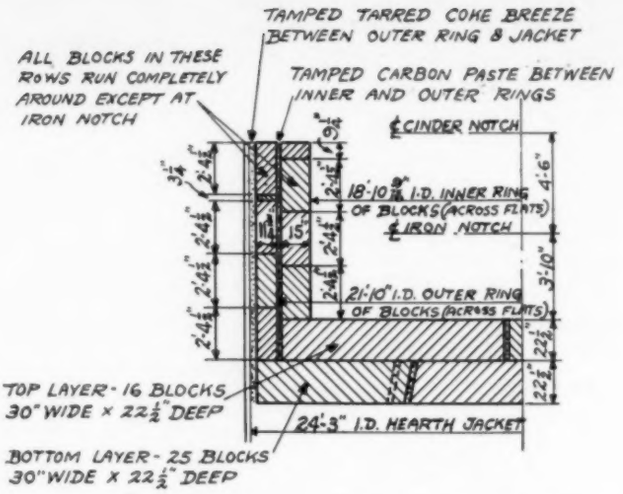

TAMPED TARRED COKE BREEZE BETWEEN OUTER RING & JACKET
ALL BLOCKS IN THESE ROWS RUN COMPLETELY AROUND EXCEPT AT IRON NOTCH
TAMPED CARBON PASTE BETWEEN INNER AND OUTER RINGS
℄ CINDER NOTCH
18'-10 3/4" I.D. INNER RING OF BLOCKS (ACROSS FLATS)
℄ IRON NOTCH
21'-10" I.D. OUTER RING OF BLOCKS (ACROSS FLATS)
4'-6"
3'-10"
TOP LAYER - 16 BLOCKS 30" WIDE x 22½" DEEP
24'-3" I.D. HEARTH JACKET
BOTTOM LAYER - 25 BLOCKS 30" WIDE x 22½" DEEP

Figure 5 — The first installation of large carbon blocks in double courses in both hearth pad and walls was in E furnace of Bethlehem Steel Co., Bethlehem, Pa.

brick, with about 2 in. of rammed carbon material between the two layers. The carbon wall block ranges up to a maximum of 45 in. in length, and the wall extends up to the top of the hearth jacket. The top of the carbon hearth pad was located 4 ft 9 in. below the center line of the iron notch.

Still in operation after four years, this furnace has produced almost 1,500,000 tons of iron.

The first American installation of large carbon blocks in double-pad, double-wall design was in E furnace (Figure 5) of Bethlehem Steel Co. at Bethlehem, Pa. This furnace has a hearth diameter of 19 ft, with the hearth pad a 45-in. double layer of large carbon block. The carbon blocks are 30 in. × 22½ in., with varying lengths. The bottom course is composed of 25 pieces, and the top course of 16 pieces. Abutting ends of the blocks of the bottom layer are slanted so as to tie in the center blocks by a wedge action. On all faces, 2-in. joints were left and filled with rammed carbonaceous paste.

The double carbon wall is constructed of two principal sizes of blocks: 11¾ in. thick × 2 ft 8⅛ in. long × 2 ft 4½ in. high in the outer layer, and 15 in. thick × 2 ft 4⅞ in. long × 2 ft 4½ in. high in the inner layer. Carbon paste is tamped between the two layers and tarred coke breeze is tamped between the outer wall and the hearth cooling staves. The outer wall rests upon the bottom layer of the carbon hearth pad, while the inner layer rests upon the top layer of the hearth pad. The carbon walls extend up to the top of the hearth staves.

This furnace has operated for more than four years and has produced approximately 890,000 tons of iron. During this period, this furnace has been off for relining of the upper part of the stack.

One of the most recent installations, No. 4 furnace at the Youngstown plant of Republic Steel Corp. (Figure 6), has employed a keyed design on the hearth pad. Furnace hearth diameter is 17 ft 9 in. The pad is formed of two courses of large blocks, the lower 22½ in. thick, the upper 29¼ in. thick, of various widths and lengths. All blocks are laid with joints as tight as possible, with a little carbonaceous cement. Abutting ends of the blocks of both courses are slanted so as to

offer a wedged construction. In addition, graphite keys or pins, 7 in. in diameter and shaped like two truncated cones placed base to base, are inserted in shaped holes spaced about 3 ft apart along the sides of the blocks of both courses, keying every block to the adjacent one on both sides.

The sidewall, which rests upon the top course of the carbon pad, consists of a single course of carbon blocks 24 in. thick, backed up by 2¼ in. of rammed sillimanite and 4½ in. of sillimanite brick. The carbon wall extends up to the bottom row of cooling plates. This furnace has just recently been placed in operation.

Two other installations have been made recently in which the carbon hearth pad is keyed in place.

Another keyed hearth pad design has been suggested, in which bars of graphite are placed in grooves cut in the sides of the bottom blocks, half of the groove in each of two adjacent blocks. No installations of this design have been made as of this writing.

A design recently announced by H. A. Brassert is pointed toward excluding moisture or air that would attack the carbon lining. This design uses a gas-tight welded shell with integral inverted dome bottom enclosing a carbon hearth pad of three courses of carbon block totaling 85½ in. in depth, a carbon block crucible wall backed up by a ceramic course, and a carbon brick lining extending about half way up the inwall of the furnace. Under the carbon hearth pad is an equal or greater depth of ceramic refractory. All cooling within the lining has been eliminated with the exception of tuyere and cinder notch coolers. The lower inwall, bosh and hearth jacket are externally shower cooled.

This design uses integrated welded steel construction similar to the furnace installed at Compania de Acero del Pacifico, Chile, South America, and is said to be considerably cheaper than the usual design of mantle and columns.

Actually, the idea of completely enclosing the hearth of a blast furnace is not new, as a German installation, described by Gayley in the 1892 paper previously mentioned, had the hearth enclosed in a steel tank, resting on I-beams.

The carbonaceous ramming material now used for filler and joints is made of calcined anthracite coal sized through a ¼-in. screen and thoroughly mixed with pitch of high melting point.

An inspection of the accompanying tabulation of carbon lining installations (Table II) shows a wide variety of design details, and indicates the uncertainty and the varying opinions attending the applications. Seven installations have only a carbon hearth floor which ranges from two 9-in. courses, through single courses of 22½ in. and 30 in., up to two courses totaling 45 in. depth.

Fourteen furnaces have been built in which the hearth walls are constructed of carbon and fire brick combined. Of these, eleven have a single layer of carbon 12–24 in. thick backed up on the outside by fire brick. The other three have a single 18-in. layer of carbon on the outside, covered on the inside by 15 in. or more of fire brick. This last design has not been used since 1946.

In only one furnace has carbon been carried above the tuyeres. This is the Chester furnace, where a 12-in. carbon lining was carried up through the bosh to the mantle.

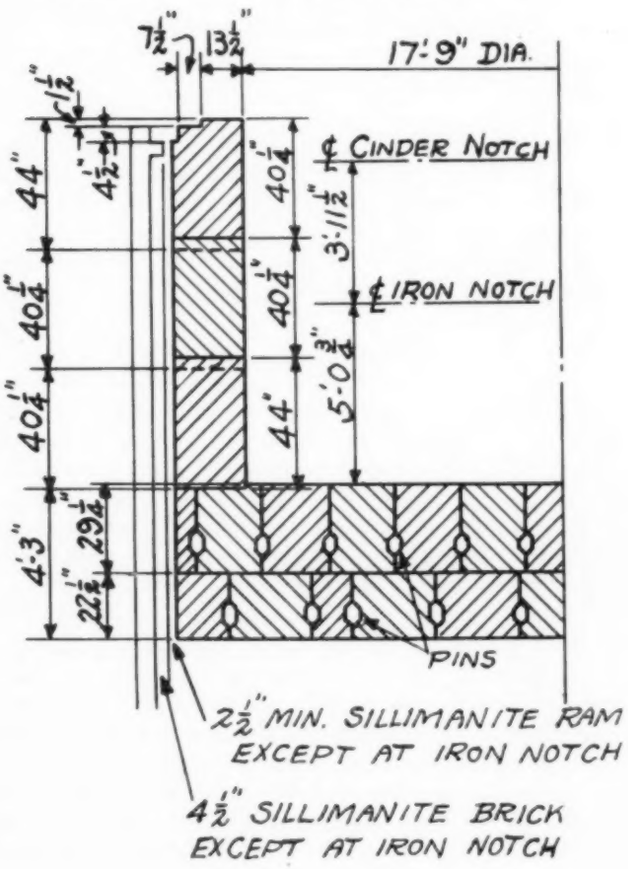
The preponderant design, of which there are 53 installations, entails a carbon hearth pad with double carbon walls. These hearth pads consist either of a single layer 22½–30 in. thick or of two courses totaling 24–52 in. in thickness. The double walls generally consist of two courses totaling 24–30 in. in thickness, and variously extend up to the top of the hearth cooling staves, up to the second or third row of cooling plates, up to the cinder notch, or up to the tuyeres.

Three other furnaces have their sidewalls built of a single layer of carbon block 24–30 in. thick, instead of two thicknesses.

In all carbon installations, a single course of fire brick over the carbon is generally used to protect the carbon during the blow-in.

Some details of design and construction have varied considerably. This is particularly true of joints, which were first recommended to be made as tight as possible, later changed to 1½–2 in. filled with ramming mix, and are now coming back to the idea of the tight joint. This variation may be attributed to a lack of understanding of the expansion characteristics of carbon. Recent test work has shown that the expansion of carbon through the temperature range encountered in the blast furnace is of the order of 0.6-0.7 per cent and does not require the wide joints previously thought necessary, but permits the carbon blocks to be laid tight. Expansion can be taken care of by 2–3 in. of rammed material around the outer edge of the hearth pad. Research work has also shown that carbon made from certain types of coke and properly baked does not have an after-shrink-

Figure 6 — The first carbon hearth installation with blocks keyed to each other was this design, installed in Republic's No. 4 furnace at Youngstown.



age sufficient to cause cracks when the material returns from operating temperature to atmospheric temperature.

There are a number of proponents for a fire brick wall (not necessarily of great thickness) enclosing the carbon hearth wall to seal the carbon from the effects of moisture, etc. Others, however, feel that the carbon should be laid directly against the hearth jacket so as to obtain maximum cooling.

Of the 77 installations listed, 17 furnaces have been out of operation at one time or another since the carbon was installed in them and have been inspected to varying extent. The following gives brief summaries of what was found and what was done:

Furnace A — 28 ft 6 in. hearth diameter. Single carbon hearth pad. Single carbon wall, backed up by 6 in. of carbon paste and 27 in. of fire brick. After only 65 days of operation and a production of 65,000 tons, a serious breakout occurred near the cinder notch. Subsequent explosions made investigation difficult. A large opening was formed through the side wall. All of the carbon hearth pad was gone. Much of the fire brick backing had been washed away around a considerable portion of the furnace circumference. It could not be determined whether iron and slag entered into the wall at the iron notch and penetrated through the new brickwork back of the carbon, or whether penetration occurred directly through the carbon at the point of breakout.

This furnace has since been rebuilt with a ceramic lining.

Furnace B — 21 ft 11 in. hearth diameter. Double carbon hearth pad. Double carbon wall. After two years and 41 days, and a production of 800,000 tons, a breakout occurred at the iron notch, where a section about 6 ft × 8 ft came out. This section was filled in with 27 in. of fire brick and the furnace put back into operation.

Furnace C — 26-ft hearth diameter. Double carbon hearth pad. Double carbon wall. After 160 days operation and 200,000 tons production, a breakout occurred in the iron notch area. The hole was filled with carbon brick and carbon ramming mix, and the furnace put back into operation after a six-day outage.

Furnace D — 19-ft hearth diameter. Double carbon hearth pad. Double carbon wall. After two years and 69 days operation and a production of about 500,000 tons, this furnace was taken off because of lack of business. It was blown down to 10 ft above the mantle and washed out. Inasmuch as all of the lining looked good, the hearth and walls were not cleaned off, nor was the carbon drilled for exploratory purposes. The furnace was put back in operation without any lining repair.

Furnace E — 19-ft hearth diameter. Double carbon hearth pad. Double carbon wall. After 2 years and 59 days of operation (516,550 tons production) this furnace was taken off for a mantle reline. Inspection indicated a maximum wear of 13 in. on the bottom and 2½ in. on the walls. The outer wall, however, was found to be soft on the hot side, indicating oxidation by moisture. This outer wall was removed and replaced with carbon and fire clay brick. A fire brick iron notch was put in place of the carbon notch, which showed considerable erosion. The carbon bottom and inner wall was left intact.

Furnace F — 15 ft 9 in. hearth diameter. Single carbon hearth pad. Single carbon wall carried up through the bosh. After slightly more than four months of operation, this furnace was banked for business and economic reasons. It has not been put back into operation or emptied out. No inspection has been made.

Furnace G — 17-ft hearth diameter. Double carbon hearth pad. Single carbon wall. After one year and 140 days of operation (about 250,000 tons production), this furnace was blown out because of lack of business. The bottom, which looked satisfactory, was not explored. Walls also looked good, but the iron notch showed erosion and was rebuilt with fire brick.

Furnace H — 18 ft 8 in. hearth diameter. Double carbon hearth pad. Double carbon wall. After one year and 130 days operation (379,270 tons production), this furnace was taken off because of lack of business. At first inspection, carbon looked to be in excellent condition. Ten core drill samples were taken from the hearth, and showed 1½ in. of bottom wear and part of one carbon block gone out of the top course. It was also found that as much as 1½ in. of iron had penetrated between the two bottom courses and as much as 5 in. under the lower bottom course. Side walls appeared to be in good shape. All carbon was torn out and replaced with fire brick.

Furnace I — 27 ft 2 in. hearth diameter. Double carbon hearth pad. Double carbon wall. After 26 months of operation (888,408 tons production), this furnace was blown out for a stack reline. A 293-ton salamander was tapped out. Inspection by drilling indicated the bottom to be eroded in the shape of an inverted cone 87 in. deep, extending through the carbon pad and some 40 in. down into the brick below it. An annular ring of the carbon remained in place, some 5½ ft wide at the level of the carbon — ceramic junction. The walls were good except for some softening and erosion around the iron notch. The furnace was put back into operation with no repair to the bottom, some repair with carbon blocks and brick in the outside hearth wall, and a new fire brick iron notch.

Furnace J — 21-ft hearth diameter. Double carbon hearth pad. Double carbon wall. After only 43 days of operation, this furnace experienced a slag breakout between the carbon hearth wall and the fire brick wall above. Since business was slack, the furnace was taken off and the top course of carbon removed and replaced with fire brick.

Furnace K — 19 ft 3 in. hearth diameter. Single carbon hearth pad with carbon breast wall in iron notch area. After 13 months operation, this furnace was blown out because of business conditions. The carbon in the sidewall was in good condition. The bottom was not available for inspection.

Furnace L — 25-ft hearth diameter. Single carbon hearth pad with carbon breast wall in iron notch area. After 8 months operation, this furnace was blown out because of business conditions. The carbon in the sidewall was in good condition. The bottom was not available for inspection.

Furnace M — 17-ft hearth diameter. Single carbon hearth pad. Single carbon wall backed up with fire brick. After about seven months operation, this furnace was blown out because of lack of business. General condition of hearth walls was excellent. Exploration by drilling through the iron and slag skull indicated bottom in good

condition. Iron notch badly eroded, and replaced with fire brick.

Furnace N — 19-ft hearth diameter. Double carbon hearth pad. Double carbon sidewall. After two years operation (565,000 tons production), this furnace was blown out for stack repairs. The bottom was not explored. Walls looked good, but some erosion was evident at the iron notch. A fire brick notch in a 4 ft × 7 ft section was put in.

Furnace O — 19-ft hearth diameter. Double carbon hearth pad. Double carbon sidewall. After 8½ months operation, this furnace was banked during the steel strike and was later raked out. None of the bottom and only portions of the sidewall were available for inspection. The exposed sidewall looked good. Two pieces of carbon block (probably from the bottom pad) had floated up.

Furnace P — 25 ft 9 in. hearth diameter. Double carbon hearth pad. Single carbon sidewall. After two years and 11 months, this furnace experienced a breakout at the iron notch. The iron notch section was repaired with fire brick and the furnace put back in operation.

Furnace Q — 19-ft hearth diameter. Double carbon hearth pad. Double carbon sidewall. After more than 32 months of operation and a production of 831,898 tons, this furnace was blown out to renew the stack lining. It was blown out down to the mantle with as little water as could be used to prevent excessive top temperature. Side walls were in excellent shape. Bottom condition was not determined as salamander was not removed. Furnace blown in again with some repairs at tap hole.

In all of the foregoing furnaces, the hearth pads are constructed with 2-in. joints of rammed material.

A survey shows that 75 of the 77 carbon installations are still in operation, while in two cases the carbon has been removed. There have been four breakouts, one of which resulted in removal of the carbon, while three occurred at the iron notch and were quickly repaired, one with carbon and two with fire brick. These iron notch breakouts, plus conditions noted on other inspections as previously mentioned, led to misgivings on the part of some engineers and operators.

Of the 77 installations on the accompanying list, (Table II) 52 originally had carbon tap holes, 21 had ceramic tap holes and four used a combination of carbon and ceramic. Of the 52 carbon tap holes, seven have since been changed to fire brick which, with the two complete carbon removals, leaves 43 carbon tap holes still operating. Some operators absolutely condemn carbon tap holes, while others have experienced no trouble and believe that the bad experience has come from excessive blowing on the hole, excessive amounts of water in the tap hole clay, water leakage, insufficient cooling, poor design or poor tap hole practice.

There have been a number of slag breakouts, one of which resulted in removal of the top course of carbon wall. Most of the slag breakouts have occurred between the carbon wall and the brick wall above, and have been easily repaired. Some operators believe that carbon walls should be carried above the tuyeres to remedy this. Some also feel that the joint between carbon and brick should be staggered rather than straight across.

A partial hit-or-miss canvass of operators who have had experience with carbon in blast furnace hearth construction reveals an interesting range of opinions and contradictions:

"Carbon is good for sidewalls and locations that can be cooled, but of doubtful value for bottoms. Carbon and fire brick should not be combined in a wall. Heat economy is not seriously affected by carbon."

"With carbon, the size of the casts is more uniform. It is easier to come off a bank; good iron is obtained quicker."

"The all-carbon tap hole is successful."

"The tap hole would have been improved by clay."

"Carbon is excellent if properly cooled and properly installed. Improvement in design is necessary, particularly in cooling and sealing against gas flow."

"Water, carbon dioxide and other oxidizing agents must be kept away from carbon."

"We believe that a thin layer of fire brick around the outside of the carbon walls seals and protects the carbon. Carbon is no good for tap holes."

"Carbon was needed because of excessive failures of ceramic linings. We believe several campaigns are possible from carbon, but carbon may be hard to justify if ceramic linings improve in quality. Our experience with carbon has been good due to good operation, care in design and installation, and use of enough carbon in walls and bottom."

"I think the carbon is gone around the tap hole, and the bottom may be gone. I would not install another."

"Our carbon lining has already exceeded the life of the two previous ceramic linings in this furnace, and appears good for some time. The tap hole is easily maintained and does not vary in length."

"The outside of carbon blocks at the tap hole looks to be in very good condition. We have had no trouble in two years, and are completely sold on carbon."

"The economics remain to be worked out in the United States."

"Our carbon lining is good as far as we know. Operation is good and we are maintaining a 4–6 ft tap hole."

"Our carbon-lined furnaces have given no trouble. The carbon tap holes are maintained at 4½–5 ft. Until more experience is available as to life, however, I would not install another — I don't know why."

"The carbon tap hole is O.K. From the way the furnace casts, some of the bottom may be gone. I have an open mind, but want more data before deciding on another one."

Perhaps the last two quotations express the frame of mind of many operators. Many are waiting — waiting for experience on life, for economic justification, for possible improvements, for assurance of reliability. Meanwhile, others are proceeding with installations trying out new ideas designed to overcome faults previously encountered and to improve previous results. Concurrently, time is unfolding the story. The oldest American application is only about five years old, and most of them are much more recent. As of mid-1950, 14 or 15 hearths with carbon in their construction have passed the 1,000,000 ton mark, and more are approaching it. One, with only a carbon hearth pad, has passed the 2,000,000 ton mark. Another, with carbon hearth and carbon wall, has surpassed 1,700,000 tons. Four carbon hearths have survived relining or repairs of other parts of the lining. The future will bring the answer.

INVENTORY TIME

By H. B. JORDAN
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H. B. JORDAN

. . . . the first of three featured addresses given at the general session of the 1950 Convention of the Association of Iron and Steel Engineers . . . .

▲ THIS is your mid-century meeting. I cannot think of a time when you have had a more important job on your hands than you do in this final week of September, 1950—a time with so many conflicting situations. And I can think of no one group in our society—with of course the exception of our Congress and the administrative officials of our government—which has the opportunity to perform a greater service to the nation than you men of the Association of Iron and Steel Engineers.

I am here, not as an outside observer, but as one of your industry, for I have been in the steel and wire business for 35 years. I share the pride which I know all of you have in the past accomplishments of the steel industry, and that is why I am particularly conscious of the challenge of the days ahead.

The half-way point, the year 1950, is a good time to take inventory, to make an examination of our consciences, of our past performance, and of our plans for the future. For a few minutes I would like to talk with you as to where we stand today, and then offer a few observations on what lies ahead of us for tomorrow.

We have gone through two world wars. We have experienced depressions and boom times. We have seen tremendous advances in automobiles, appliances, radio, television and all the other things which have made our standard of living the highest in the world.

During this comparatively brief period of 50 years the United States has assumed a position of world leadership in industrial production. Important strides have been made by other nations, too, but while one country and another have slipped and stumbled under the load of some "ism" or other, America's industrial production has gone steadily forward, in war and in peace, adding consistently to our national well-being and strength.

This progress has been made by free men, living and working under the American system of free, competitive enterprise. These free men have built in this nation a strong and healthy industrial economy, which is perhaps one of America's greatest assets.

The steel industry has played a major part throughout the entire half-century, because steel is the backbone of our industrial economy. Steel forms the basic part of our national industrial machine, whether that machine be a tank or a farm tractor, whether the most urgently needed items are bullets or one of our many peace time products.

Perhaps you have the idea that I am proud of the job the steel industry has done. That is exactly right. Never was this more clearly demonstrated than during World War II and never did the steel industry fail to meet the demands imposed upon it by the military program. You all know the story as well as I do—close to 47 million ingot tons of steel were produced for direct war uses in 1943.

Now here we are in 1950, and what is the situation today? For several years we have been a participant in an uneasy world situation which we have come to describe as a "cold war". Then suddenly, a few months ago, came a new and explosive development in a tiny country thousands of miles from American shores. Korea is a familiar name to all of us now. Every newspaper headline, every radio news broadcast, is a grim and sobering reminder to this nation that American soldiers, sailors and marines are fighting and dying in an effort to preserve international peace and security.

Korea may continue to be described in military terminology as a local incident, or it may touch off another war even more devastating than the last. But one thing is certain—the fighting in Korea has called for individual sacrifices as great as those on Normandy beaches or on Okinawa. It is just as serious and as real for the young men in Korea as though it were a wholesale war, and it is just as serious and as real for the families of those young men and the families of the other boys who are entering the nation's military service every day.

Another thing is equally certain—America's industrial machine must be ready for whatever demand may be made upon it. Korea has served notice upon us that this nation's industrial might must continue to be the greatest in the world.

The implications of atomic warfare are almost too staggering for us to comprehend. It seems unreal to us as we see the civilian defense organization in our cities and towns being reactivated. It seems unreal to us, too, when newspapers publish maps of our cities showing the areas which would be wiped out by the blast of an "A" bomb or an "H" bomb.

Of course I do not profess to be a military analyst and certainly I can not predict about what is going to happen next in Korea—or in Formosa, or in Indo-China, or anywhere else on this uneasy planet; but I do know that the vast majority of the people of America are united in their determination that Communist aggression must be stopped sometime. I believe that thinking Americans are conscious of the grave threat to their personal liberty which would be presented by major Communist expansion.

While I am not close to our military situation, I feel that I am part of our nation's industrial machine and particularly of the steel framework of that machine, and I like the way that machine has run—and will continue to run if it is given the chance.

There seems to be the opinion in some quarters that the steel industry does not have sufficient capacity to take care of possible war needs. That opinion, in my book, is not correct.

The American steel industry today has a capacity of 100,000,000 tons—and that is 14 per cent more than all the rest of the world combined. More than that—there are in excess of 5,000,000 tons of additional steel capacity scheduled for completion within the industry by the end of 1952, which will bring total capacity to nearly 106,000,000 tons. (United States Steel alone is expanding its capacity by 1,660,000 tons.)

Today's capacity is 12,000,000 tons more than the industry produced in 1943, the big year in steel shipments in World War II. However, we must remember that the population of this country has risen 10.5 per cent between 1943 and 1950 and that there is a greater per capita demand for steel resulting from our rising standards of living. It is obvious that increases in military demands will entail a reduction in the amount of steel available for civilian use.

It is difficult to conceive how any enemy or group of enemies could present any problem to this nation so far as steel is concerned, providing the steel is used in the right place at the right time.

The stronger position is not confined to steel. America's total manufacturing capacity and its electric power production are far greater than they were a decade ago. One of the nation's great companies—our largest producer of electrical equipment, has announced that in the event of an all-out mobilization it can produce substantially double what it produced during World War II.

I mention that big company with the full realization that it has not been popular in some quarters to talk about "big companies" in complimentary fashion. To me, this thought is one of the mysteries of our time.

You'll recall that the government sang the praises of America's big companies because of the production miracles accomplished during the last war. As soon as the war was over, the story was different. Steel companies particularly were criticized for not being able to produce instantly all the steel needed to meet the tremendous civilian demand accumulated all during the war. There were threats that the government would build steel plants. The big companies were urged to expand their facilities, and as you know, have done so.

Then the tune changed. The government attacked steel companies for being too big. The Celler committee investigators took the tack that small companies were being gobbled up and had to be protected from the big companies. You will remember the charges at the monopoly investigation. Every effort was made to draw a hard and fast line between big business and little business—to suggest they worked opposite sides of the street and that never the twain could meet.

You know the facts. You know that big business and small business alike are indispensable to our national welfare. You know that big business and small business have grown together in this country. You know that big companies buy their supplies and parts from thousands of other companies, large and small, and sell their products to thousands of other companies, large and small.

Now, in the last few weeks, the tune is changed once more. The big companies are being called upon to do the big jobs that only they, with their reservoir of talents and skills and technical knowledge, are equipped to undertake. The biggest automobile company is given the job of making tanks, right here in Cleveland. That biggest electrical company I mentioned a few minutes ago and the biggest chemical company, both of which have been favorite targets for the anti-trust group, are selected by the government to perform an extremely important assignment for the Atomic Energy Commission. The fee is ONE DOLLAR.

That welter of confusion in the attitude toward business, particularly big business, sounds a little ridiculous, and it might be even laughable, too, except it has such sobering implications.

It is part, gentlemen, of an effort that has been going on a long time to undermine the very structure of the economic machine which has made this nation great.

You men of the Association of Iron and Steel Engineers—as engineers and operators, are realistic and practical. You can readily spot the fallacies in the arguments of those who would attack business and industry. You are meeting here, as you always do at these sessions, in an effort to arrive at a better understanding of your common problems by mutual discussion. In short, you are interested in better ways of making steel and steel products. You are not assembled for the promotion of the welfare state, and you do not believe in the rosy promises which have been made by the theorists and the dreamers—by men without practical experience.

But the attempt to break down the functioning of our industrial performance does concern you. You know the kind of demands that industrial mobilization would make upon you, and you are prepared to do the job if you are called upon to do so again.

You must play your part—and it is an important one, in producing enough tanks and guns, bullets and flame throwers, bazookas and atom bombs to build a defense machine that will be strong enough to resist aggression, the kind of aggression which endangers America.

You will do that job, I know.

But I submit that you have another urgent demand upon you and much depends on how you meet that demand.

You have a job to do with those people who are not entirely sold on the American economic system, those people who believe it is wrong to make a reasonable profit, who believe there is something evil in being large and successful. You have a long succession of "something-for-nothing" arguments to overcome. Lots of folks have fallen for that story of the welfare state doing the planning for all the citizens, providing security for all, doing it the easy way. That story can be made to sound fairly convincing, and there are many who believe it.

You must win over the "something-for-nothing" people. You have to show those who do not believe in our system that it provides more of the good things of life than any other system.

Of course you cannot do it with a lot of talk about the glories of the free enterprise system. You must do it with actual goods and materials—automobiles and ashcans, refrigerators and rat traps, stoves and steamrollers, washing machines and windmills, TV sets and teaspoons, yachts and yo-yos—all of the wonderful, silly, great, insignificant, fine and foolish things—that Americans feel they need in order to lead an ever better life.

You and other men like you have done an excellent job—to this point. One of the best reminders of that fact is an automobile—not necessarily one of the big or expensive ones, but any automobile. Remember the bearing knocks you used to hear in most cars? You do not hear them today—thanks to you and the automotive engineers who kept on working for a long time on the problem. How many times do you hear of a valve spring breaking today? When you consider that in a car traveling 50 miles an hour a valve spring is compressed and released 1,250 times a minute—or 75,000 times an hour—that is quite a tribute to the men who developed and produce the material from which the springs are made and the men who make springs. Remember the cumbersome construction of a car a generation ago? We have learned a great deal about the making, forming and shaping of metal.

We could go on indefinitely with illustrations, but it all adds up to the fact that tremendous technological advances have been made in recent years. Do you remember the song of the girl who had been "done wrong by"? "You made me what I am today—I hope you're satisfied." I mention it with a very different connotation. Instead of censure, it is a compliment. You men are entitled to a large share of credit for the strides we have made in this industrial machine of ours. Now for that second phrase: I hope, gentlemen, that you are not satisfied. I hope you are never so satisfied with the job you have done that you allow yourselves to become complacent.

Let us recognize that we have actually only scratched the surface in many phases of this iron and steel business. We must keep on working constantly to find stronger and better steels. We must improve our practices in alloying, so that we get the maximum utilization of the valuable properties of steel and of other materials that can be combined with it. We in the Wire Company feel pretty proud of ourselves sometimes, and then we remember some of the longstanding problems in our business, such as putting aluminum coating on wire without sacrificing any of the wire's tensile strength. Now the melting point of aluminum is approximately 1300 F. That happens to be also the annealing temperature of wire. So what happens? We get a good aluminum coated wire—but it is soft wire again. That problem will be solved some day—but it will take a lot more work by men like you. And that is only typical of the jobs we have to do to continue making progress in this field of ours.

Every time we see an airplane it should be warning to us, a warning against complacency. Back in the 1890's the United States Patent Office was rejecting, without even making any examinations, all applications for patents relating to devices designed to fly by power-driven machines. In 1902, after the Wright Brothers had made their first successful glider flights, they were casting about for a gasoline engine suitable for a power-driven airplane. They could find no enginemaker who would bother with a job of making for them an engine as light as called for by their specifications. So they decided to build their own engine, and they built one of the four-cylinder horizontal type, developing 12 hp. They applied for a patent. The Patent Office turned them down, on the grounds that such a machine was "inoperative". It was not until 1906, when the Wrights had been flying their "inoperative" machine for three years, that they finally were granted a patent.

You gentlemen have been holding a number of sectional meetings the last few days, and in many of them you have been discussing various phases of the broad subject of production. I would like to consider that subject with you too, because it is of paramount importance.

A British trade union mission which spent six weeks in the United States a few months ago reported it found nothing to support the belief that the American works harder than his British cousin. It agreed with previous missions to the United States that the American worker's efforts are frequently more effective, but said this was due to the greater use of machinery, mechanical handling and lifting equipment, and various other factors.

Certainly, technological progress cannot be denied as being the motivating force which has raised the productivity of the American worker—and has raised his income along with that productivity. Figures show that over a period of years output per man-hour increases an average of 2 to 3 per cent annually. Some periods may be higher; others lower, but that is the average.

Looking at this fact impersonally, it would seem only fair that the benefits of that productivity increase should be divided among consumers, workers and owners.

But what has happened in the past few years? The basic labor rate has increased 100 per cent during the 9 year period since 1941. Assuming that the productivity of the individual industrial worker has increased an estimated average of 2 to 3 per cent in each of those years, we would arrive at a productivity increase of approximately 25 per cent, which is far below the rate of increase which has occurred in wage rates. And, mind you, that is in effect giving the worker the entire increment, without counting in the buying public and the owners for their fair share.

One conclusion could be drawn from these facts —that is, productivity has not been able to keep pace with wages. In other words, the future productivity of our industrial economy has been mortgaged until such time that technological progress can catch up.

This fact is a real challenge to you and your associates. If the unit cost of industrial production is to be kept at a level which will permit selling prices to attract buyers, our engineers and technicians are going to be compelled to sharpen both their pencils and their wits to maintain their position in their continuous race.

Yes, gentlemen, there is one primary answer to the problem of meeting both the military and the civilian demand—or as one writer puts it, the job which the American economy must do is to provide both guns and butter. That answer is production. Yours is the key role in showing us how we can increase productivity.

Now productivity, as it applies to steel production, actually means the effective rate at which men, machines, and materials are utilized to convert raw materials into basic steel and steel products which are required by the customer. Naturally, the effectiveness with which each of the forces of men, machines, and materials is used has a direct bearing upon the overall effectiveness.

Productivity in steel is the overall result of a number of factors. One is demand—or the volume of the customers' requirements. This is a most significant factor. Steel plant operations involve a great many jobs which must be filled, regardless of whether a plant is running at a high or low rate. As you know, it takes as many man-hours to start up a furnace and to get equipment ready for one day's work as it does for five or six days' operations.

It is quite obvious, then, that if the volume demand varies widely, from day to day, then so too will the tons of product output per man-hour. Let us take the steel-producing subsidiaries of U. S. Steel to illustrate the point. At 30 per cent capacity operations, the quarterly shipments of steel products by the companies would be 1,654,000 tons. At 95 per cent capacity operations, the quarterly shipments would be 5,237,000 tons. Based on average experience of the last 15 years, the man-hours per ton for each of these two volume levels would be about 32 for 30 per cent capacity operations, and 18 for 95 per cent capacity operations. In other words, the man-hours per ton would increase about 71 per cent when operations dropped to 30 per cent. This relationship must be improved.

This particular demand does not arise right now, of course, owing to the high volume of consumer demand. But someday, we will be back in a normal market. The long-range challenge to you, in this field, is to keep a part of your research and product development efforts directed toward the creation of new consumer needs and desires for products made of steel.

Another factor in productivity is that of product mix. Taking the U. S. Steel Corp. again as an example, as you probably know, it produces literally hundreds of thousands of different steel items. For instance, it makes 153,000 different sizes, shapes, and finishes of hot rolled bars—13,000 hot rolled strip items—130,000 different sheet items—23,000 oil country items—and 370,000 drawn wire items. And this does not include the more than 350 various steel compositions which we must be prepared to furnish in these items!

In this area engineers can play an important part, because it is my guess that in many cases specifications call for specialized items when standard items would do the job perfectly. I know of one case where the specifications for a certain steel casting called for limits in terms of a thousandth. The supplier checked and found the casting was for a handle, and there was no fitting involved. You can relieve your suppliers' problem and save your own companies money if you consider this angle when you are writing specifications.

Production planning is a very important factor in total output per man-hour. Fortunately, we have made great strides in recent years in the science of scheduling our productive equipment. But there is still room for improvement in this field.

The challenge to you is to devise increasingly better ways, means, methods, and procedures for planning and scheduling your productive equipment.

You all know that productivity can be increased by creating longer runs on individual products, and you often can increase the cycle by careful planning and grouping of orders.

A third factor on productivity is the effect of the quality of raw materials. My long and respectful acquaintanceship with blast furnaces makes me appreciate, as you all do, that the quality of raw materials is of vital importance in the production of pig iron.

If you have a high-grade coke, production goes up, other things being equal. The same with iron ore. The size of the ore and its chemical content have a decided influence on blast furnace operations. You all know of the work that is going on today in the processing of taconite concentrates, the work being done to make use of vast quantities of low grade ores. You men share the responsibility of improving the quality of all materials used in the steel industry.

A fourth factor in productivity is capital improvements, or the nature, condition, and amount of production facilities made available by owner investment. Companies throughout the steel industry have been expending millions of dollars, as you know, on not only the expansion program I have mentioned but in rehabilitation and improvement of existing equipment. There are numerous illustrations of how this improvement in the tools of production provides long-range benefits—more jobs, increased output, greater production per man-hour.

Capital investments in facilities are going on constantly. In this field engineers have the job of making dead certain that the money is expended in only the best, most modern, and most efficient plants and equipment.

Another of the important factors in productivity, and one which is becoming increasingly recognized as having a major influence, is that of employee performance.

The human element is involved in every step of steel making operations. Some people must direct. Some people must be directed. The machines cannot run by themselves. Someone has to plan the operations and someone has to turn the switch and pull the levers.

We can have the finest of tools and equipment—the highest quality raw materials—the best of operational plans—but if the people who actually do the work do not carry their fair share of the load then productivity takes a nosedive—and quick!

Human relations is one of the most important aspects of industry today. We have come a long, long way from the days when the boss had to be big enough and tough enough to lick any man who worked for him. Cooperation of labor and management equally is of constantly increasing importance in productivity today.

The philosophy of a fair day's work for a fair day's pay, which has been introduced into industry in recent years is a refinement of long years of work in this direction and definitely evaluates and measures the contribution made through human effort. Engineers have played a vital role in this project. The studies you have made, the standard you have set, the benchmarks you have created, have been of the greatest value in making a practical, working management tool out of what was once theory.

There is much work yet to be done and the challenge to you is to continue your efforts to constantly refine your techniques of measuring, weighing, and evaluating human performance and its most productive application.

There is a challenge to you, also to make the tools and techniques of modern human relations a part of your working kit in your everyday job of meeting and dealing with people. For people, after all, are not to be measured as so many ergs of energy or decimal points on a slide rule.

They are real, flesh-and-blood people having the same basic feelings, emotions, needs and desires as you and I. Let us not forget that fact in any of our dealings with our fellow-men. Management must cooperate and be fair—but most certainly must labor unions drop the worn out song—that management persecutes and exploits labor.

Now we come to the field in which you, as engineers, can make another great contribution to increased productivity. I refer, of course, to the improvement of methods and practices.

The job of searching out and perfecting ways and means of improving operating methods and practices is, as you very well know, a never-ending one. Some efforts may be on a large scale. Others may be much smaller, such as the simple re-arrangements of machines and reassignment of employees duties which was made at one plant and which resulted in increased output per man-hour of 86 per cent, without requiring an increase in employee performance.

Materials handling is another example of how productivity can be increased. Every time you pick up material, move it to another place, and set it down you do two things. You lengthen the process time and you increase the cost. But you do not do a thing to increase its value.

The entire steel industry, from the mine to the customer, is full of opportunities to improve methods and practices. Perhaps your greatest challenge lies in this field. Realistic accomplishment will greately benefit the employee and the public.

I have suggested six broad areas in which the iron and steel engineers can make significant contributions to this matter of productivity. One more thought: let the parties to labor contracts continue to recognize them, both morally and legally. It would be deplorable should they cause wildcat strikes as a transparent excuse for the failure to keep these contracts.

There is no need to dwell further upon the point of today's uneasy world situation. I am sure that all of us recognize the seriousness of the day-to-day developments in the international field, and that all of us stand ready to assume any task we are called upon to perform in industrial mobilization. And while we do that, gentlemen, let us keep our eyes on the long-range picture. Let us be mighty careful that we do not permit the passage of legislation during the time of emergency which would pave the way for conversion of this nation of ours into a permanent socialist state.

Let us continue to do the kind of a job which will prove to all of our people—and to the entire world—that this industrial economy of ours is our bulwark of defense against aggression—and that it is the foundation on which we have built the greatest way of life ever known to any group of people in the world.

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ENGINEERING AND PURCHASES

By THOMAS D. JOLLY*
Vice President, Engineering and Purchases
Aluminum Company of America
Pittsburgh, Pa.

THOMAS D. JOLLY

. . . . the second of three featured addresses given at the general session of the 1950 Convention of the Association of Iron and Steel Engineers . . .

▲ I propose to discuss the relationship of engineering and purchasing. If it is true, as I believe, that the activities of engineers and purchasers are directly reflected in the larger American economy, then this is a very appropriate time to be discussing the subject. We appear to be entering another period of profitless prosperity.

Only last spring, the young people graduating from our schools were finding it hard to get jobs. Unemployment stood at three to five millions, depending on who was telling it, and prices were softening. You could buy a car without a sun shield and in any color you wanted. That was only four months ago, but what a change has taken place! Many materials are being allocated and some are almost impossible to obtain. Wages and prices have been going up, and escalation clauses have returned. The young graduate is getting choosy again, and so are automobile salesmen. We are about to go into a war economy.

There is, of course, no economy in war. When you devote your energies and resources to destruction, you create waste and debt. Up to now, at least, this has always resulted in inflation of the economy. Coming on top of an already bloated economy, it is a matter of serious concern to all of us.

A large part of our present boom has unquestionably been caused by scare buying. Heads of families have acted as they have been acting since the year one: they have sought to protect themselves against shortages and higher prices by accelerated and increased buying of sheets, towels, television sets, sugar and what have you. Industrial buyers have done the same thing in their own way. The government has done it most of all. The stockpiling program which had been dragging along was stimulated into sudden activity on June 24th.

I sometimes think the Swiss handle these matters much better. In that country, I am told, every householder must prove in time of peace and plenty that he has hoarded so many pounds of flour, sugar and other supplies as a personal stockpile against an emergency.

In any event, all this can result only in further inflation. The public debt has been multiplied by seven in the past ten years, consumer debt is greater, and federal expenditures are spiraling upward.

Now I would say that there are three things we can do to remedy or at least to alleviate this condition. We can forcibly persuade Mr. Stalin and his friends to stop grabbing real estate and let us return to a post-war economy again. We can try to make net national production go up faster than prices and the public debt by speeding up technological development and discovery. And we can cut the costs of industrial production.

I think we had better leave the first of these courses, at the moment, to General MacArthur. The second course has already resulted in the most amazing half century of economic progress ever achieved by any country. Improved engineering has brought a reduction in the average weekly hours worked by each individual worker from about 58 in 1900 to less than 40 today. It has brought an even greater reduction in the physical effort required of him. Despite this, we have increased the amount of goods consumed per person by two and one-half times.

Shorter hours and higher wages mean higher costs in any language and in any era. In the past 50 years, we have offset these higher costs by increased mechanization. A great deal of this can still be done. We can still reduce costs by improving plant layouts, machinery and production methods. But in many cases the capital cost of increased production by these methods is greater than can be justified by the return from the investment.

This means that we must explore all other possibilities for cutting costs. Industry has got to do every possible thing it can do in the next few years to cut costs. We pay out more these days for construction, materials, equipment, labor and distribution, and this has raised the break-even point to a new high. This program calls for the cooperation and support of all departments, but it particularly calls for cooperation and support from those high class hired hands known as engineers and purchasers. In this effort, engineering and purchasing are the key departments.

When we try to measure the responsibility, we find

* Because of the unavoidable absence of Mr. Jolly, this paper was read by R. O. Keefer, purchasing agent, Aluminum Company of America.

that the average expenditure for materials and fuel requires 56.6 cents of the American sales dollar. The percentage controlled by the engineer is harder to evaluate, but it is considerable. He also has a large responsibility, of course, in the expenditures made by the purchasing department.

You know as well as I do that the engineer has changed just about as much in the past 50 years as any other part of the American scene. For many years there has been an increasing trend toward specialization in the various branches and subdivisions of engineering. The first professional engineering society—ASCE—was founded in 1852, the AIME in 1871. These were the only two national professional engineering organizations in existence when the Engineers Society of Western Pennsylvania was incorporated in 1880. Today 33 national engineering societies join with the Engineers' Society of Western Pennsylvania in the Pittsburgh Technical Calendar, and there are many more that are not represented.

This specialization has resulted in great progress. At the same time, it is becoming more and more necessary, for scientific development is proceeding at a pace beyond the capacity of any individual. But as specialized branches become more plentiful, it is more than ever essential that we have a closer cooperation between them if progress is to continue. You are all familiar with ways in which this cooperation is being carried out. Combining all branches of engineering interested in the production of steel into one Association of Iron and Steel Engineers is one example.

If you take the profession of engineering and break it down to fundamentals, I think you might come up with this definition: the only purpose of engineering is the elimination of waste.

The civil engineer builds tunnels, bridges and roads to eliminate the waste of time and power. Mining engineers devote their efforts toward the reclamation of useful minerals with the least possible waste of natural resources and of labor and energy to produce them. The mechanical engineer designs machines and equipment to produce useful articles with a minimum of material, time and labor. All branches are devoting their talents and efforts toward the same end, the elimination of waste.

The primary duty of the purchasing agent is to prevent the waste of his company's money, spent for goods and services.

In the past 25 or 30 years, purchasing has developed from a minor clerical function to major management status. Many purchasing departments today are headed by and largely staffed with engineers. Here, too, we find various branches of engineering represented, since different skills and knowledge are needed for the purchase of commodities, equipment and services. But whatever their branch of training, all work toward one goal: proper materials in the proper place at the proper time at the proper price.

Thus both engineering and purchasing departments have the same objective, the elimination of all possible waste. Their procedures are different, but close cooperation between them in the battle against waste is just as desirable as it is between the air and ground forces in Korea.

Last November the Controllership Foundation, which is the research arm of the Controllers' Institute of America, released a report on cost reduction. It found that possibilities for reducing costs fall in four general catagories:

1. Inventory reduction and subsequent control.
2. Reduction of production costs.
3. Cutting administrative overhead.
4. Expanding sales.

Much emphasis was placed on standardization and interchangeable parts.

Last summer the British section of the Anglo-American Council of Productivity sent several teams of engineers to this country to study American productivity methods and report their observations and findings and to make recommendations. One of them reported:

"All of the evidence we have assembled endorses the advantages to be gained from simplification. As a result of our visit to the United States we are convinced that one of the main reasons for the high productivity and low cost which are characteristics of industry there is the ruthless elimination of unnecessary variety and the resultant concentration of manufacturing resources."

There is no doubt that the British were correct in their observations: elimination of useless varieties has done a great deal to develop our mass production methods and reduce costs. There is also no doubt that the Controllership Foundation was also right and there is a great deal more that we need to do.

Engineering, purchasing, inventory reduction and subsequent control, reduction of production costs, standardization and interchangeable parts—all these are closely allied. And if we are going to do a real job of cost reduction we might well invite the controllers department to join in.

One business service organization has a Commodity Classification Service which claims it can help industry save from 20 to 25 per cent on its stocks. Many companies have standards departments, some of them rather elaborate. Many have inventory control departments and stores catalogs, but few, if any, have done a really scientific job because they have not used the combined talents of engineering, purchasing and the other interested departments.

I will talk about the experiences of my favorite company. It is the one I know best and you may find a case history more interesting and informative than any amount of generalization. A few years ago the Aluminum Co. of America, on the basis of an investigation of experiences elsewhere, decided that it was desirable to have a complete catalog of stores materials. It created an inventory control department. This department, with a committee of representatives of purchasing, engineering and storekeepers, started an item-by-item study of all stores materials.

In the next four years, in only three of the company's 21 plants, we had eliminated almost 19,000 items as obsolete, non-standard, non-recurring or duplicated. I do not need to spend much time telling you that this meant a tremendous saving in inventory investment, less storeroom space required, and increased efficiency in operations, stores and purchasing.

Reduction in the number of items carried was desirable, but that was not the only or even the primary consideration. The important thing is to see that each item cataloged is the best possible item for its proposed use. This does not necessarily mean either the most expensive obtainable nor does it mean the lowest priced. It does mean the one considered right for the job, price and service both being considered. In some cases where installation costs are high, it was considered real economy to pay more for a longer-lasting item. In others it was decided we had been paying premium prices for higher quality than necessary. This work still continues. It is a work that will never end, as changing conditions will necessarily change the requirements of catalog items.

We found that many items were being stocked in accordance with specifications founded on tradition, unsupported opinion, prejudice or hunch. Many were sound at the time the original decision was made but now become obsolete. Every one had favorite lubricants, babbitt metals, tool steels, abrasives, etc. One English-born foreman insisted that no good drill rod was made in America.

All these were sincere opinions, no doubt; but we wanted facts, not opinions. The surprising thing was that all departments cooperated enthusiastically in obtaining the facts. Nothing was forced or ordered, and the entire project was and still is a cooperative effort.

This work did not stop with purchased storeroom shelf items. Each item was considered as a separate problem and the question included not only its desirability and value but how best to procure it. In one instance this resulted in the purchase of a new piece of major equipment. The machining time on an 8-in. diameter 1½-in. die blank was 78 minutes on an engine lathe and 26 minutes on a turret lathe. We found, however, that we had enough work to justify a multimatic machine which turned out this same die blank in two minutes and 20 seconds. In one year it saved us 17,060 man and machine hours.

We had 125 triplex pumps that occasionally required block replacement. We redesigned this block to three-piece construction and saved 204,700 pounds of steel for 375 blocks. The new block not only gives better service, but twelve spares held in the spare parts pool are adequate for replacement at all using points.

We used a commercial standard wherever possible, though special conditions made it necessary, in some cases, to adopt special designs, materials or sizes.

Any standard is better than no standard. There are some places where a company standard is desirable. An industry standard is still better from a purchasing viewpoint because its wider acceptance means a higher volume of production with consequently lower prices and greater ease of procurement. The advantages of a national standard are obvious.

One of the first activities of every newly organized technical society has been the organization of a standardizing committee. This is also true of trade associations. In 1927 there were 371 standardizing bodies in the United States. There was a tremendous waste of money and effort because of duplication of work and conflicting standards. So much confusion resulted that all concerned recognized the need for a central clearing house to aid in standardizing the standards. The American Engineering Standards Committee, which had been organized in 1918 to coordinate the standardizing activities of five national technical societies, was reorganized as the American Standards Association to become the national clearing house for standards and its membership was opened to any nationally recognized organization interested in standards.

The American Standards Association is not a society; it is not even an association; it is a federation of societies, and a very loose federation at that. It now has 101 member-bodies, made up of technical societies and trade associations. These own and control the ASA. Only member-bodies are represented on the Standards Council. They elect 15 of the 18 directors. ASA now has more than 2200 company members. These provide most of the money that is required to run the organization.

Your own Association is an associate member of ASA, is represented on many of its committees, and participates in its other activities. Not all ASA members understand its value to them, and since it ties in to my subject both on engineering and on purchasing, I am going to take advantage of this opportunity to explain that value briefly to you.

It is important to remember that ASA neither proposes nor formulates standards. Its primary function is to provide a means for all organizations concerned with standards work to cooperate with others interested in establishing American Standards. In carrying out this function, it serves to eliminate duplication of work and the promulgation of conflicting standards. It stimulates the work of others competent to formulate standards suitable for approval as American Standards and it assists in forming committees for this purpose when they do not already exist. It serves as a clearing house on standardization work in the United States and foreign countries. It furthers the standardization movement as a means of advancing the national economy and to promote a knowledge of and the use of approved standards. And it acts as the American channel in international cooperation in standardization work except where these fields are adequately covered by existing international organizations.

American Standards benefit every one of us in many ways we seldom think about. The first standard for traffic safety, for instance, American Standard Colors for Traffic Signals, approved in 1926, is now in use all over this country and is on the way to becoming a world standard. Standards on the use of safety glass are accepted in every state in the union. I could stand here all day and cite examples of such standards in engineering, safety, commercial and consumer fields. The following case may be taken as a typical one.

In 1919 there were 14 states that had their own requirement for the use of abrasive wheels. No two of them were alike. At the same time the insurance companies had their own rules covering abrasive wheels, and no two of them were alike. In order to obtain uniformity the Grinding Wheel Manufacturers Association proposed a code which would permit a manufacturer to make and sell one machine and sell it without changing it for each state. The government groups,

however, took the attitude that the code could not be right because it was proposed by an association of manufacturers.

This code was offered for acceptance as an American Standard and was accepted as such with very minor changes. As an American Standard it was recognized and accepted by the state regulatory bodies and the insurance companies.

This was possible because:

1. The American Standard was developed under neutral auspices.
2. The procedure brought the regulatory bodies into contact with the manufacturers, users, and technical experts.
3. The ASA committee procedure convinced the regulatory bodies that this code was technically sound.

Today all states accept the American Standard Safety Code for the use, care and protection of abrasive wheels. Every buyer and user of abrasive equipment benefits from this work. Can you imagine the confusion and cost if we still had a different requirement by each state and each insurance company?

Recently a company won its case in court because it could show that its equipment was in accordance with an American Standard.

The National Electrical Code and the National Electrical Safety Code are generally adopted by state or local laws throughout the country because they have been adopted as American Standards.

American Standards are recognized in these cases because nearly 500 organizations participate in their development. Six hundred and fifty companies are cooperating through committees totaling about 4,000 members. Every one interested in a standard has the opportunity of being heard for or against its adoption, and approval can be given only when a censensus is found in its favor.

Every standard automatically comes up for review and revision or reaffirmation every three years—in less than this time if necessary.

The General Electric Co. has organized a Value Analysis Department—a group of engineers who work with the purchasing and manufacturing departments to study each item of cost in relation to the contribution it makes toward the performance of the device. The check list includes the questions:

1. Can we eliminate the device—or change it over to another to perform its functions?
2. Can we simplify or alter it so that high speed methods can be used?
3. Can we use a lower cost material which will perform equally as well?
4. Can we use a higher cost material—which by nature and properties will afford a simplified design and lower cost product?
5. Have we checked against other methods of fabrication?
6. Have we checked unusual but available forms of raw material—preplated steel, clad metals, etc.?
7. Have we surveyed the purchasing with the buyer? Are available highly specialized suppliers being used? Have the suppliers' engineers been given sufficient facts and pressed for suggestions which would produce equivalent performance at lower cost?
8. Can we alter the device so that a standard or near standard can be used?

This is a good list, and if engineering and purchasing will work together on ideas of this kind it can result in tremendous savings. We must have a unification of forces in the war against waste. This was desirable before, but since the present war economy has arrived it is essential for all industry.

The purchasing agent should do the purchasing and the engineers should do the engineering, but if they are going to reduce costs, they must work together.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC. OF

IRON AND STEEL ENGINEER

(Required by the Acts of Congress of August 24, 1912, March 3, 1933 and July 2, 1946)

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State of Pennsylvania

County of Allegheny

Before me, a notary public in and for the State and county aforesaid, personally appeared T. J. Ess, who, having been duly sworn according to law, deposes and says that he is the editor of the *Iron and Steel Engineer* and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Acts of March 3, 1933 and July 2, 1946, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher: Association of Iron and Steel Engineers, 1010 Empire Building, Pittsburgh, Pennsylvania.

Editor: T. J. Ess, 1010 Empire Building, Pittsburgh, Pennsylvania.

Managing Editor: None.

Business Manager: None.

2. That the owner is: Association of Iron and Steel Engineers, 1010 Empire Building, Pittsburgh, Pennsylvania.

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3. That the known bondholders, mortgages, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

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T. J. ESS, Editor.

Sworn to and subscribed before me this 22nd day of September, 1950.

G. WILLIAM JONES, JR., Notary Public

(My commission expires February 9, 1951.)

THE PROPOSED NEW ENGLAND STEEL PLANT

By CLIFFORD S. STRIKE
President
F. H. McGraw & Co., Inc.
Hartford, Conn.

CLIFFORD S. STRIKE

. . . . the third of three featured addresses given at the general session of the 1950 Convention of the Association of Iron and Steel Engineers . . . .

▲ IT is my privilege, so far as the New England sponsors are concerned, a duty to address you today on the subject of the "Proposed New England Steel Plant." The qualifying adjective in the title allows no considerable latitude in discussing this subject. It is indeed a "proposed" steel mill but it is my intention today to explain to you how it is proposed and by whom. Depending on where this subject is mentioned or discussed, it is variably considered as:

1. A politician's pipe dream.
2. An ambitious program.
3. The springboard to the nationalization of the steel industry.
4. Socialistic.
5. A threat to the present New England market of some of the steel companies.
6. Finally, a well-founded business proposal organized and supported by New England industry.

I intend to speak briefly about all of these concepts, but finally to discuss with you the business aspects of this proposed mill: its conception, its present stage of development and its prospects for the future as I see them.

It is hardly necessary before this body to describe the pattern of New England's industry—past or present. You know, of course, that over a period of time we lost a good part of the textile industry, our major industry, to the south. We have also lost employment in the leather goods industry, but to a lesser extent than in textile to other parts of the country. At present, the region's principal industry is in metal-working. From 1939 to 1947, the number of metal-working plants in New England has increased from 2,970 to 5,236; employment in the industry has increased from 331,000 to 579,000, or by 75 per cent. Nearly 40 per cent of our present industrial employment is in metal-working compared with less than 30 per cent in 1939. Of course, World War II did a great deal toward stimulating this growth, but the rate has been well maintained since the close of the war.

You may be sure that those in New England who are concerned with its industry as a whole have every intention to maintain this important metal-working industry and, if possible, to increase its productivity and its production.

Even before the loss of the basing point pricing system, or even in spite of the possibility of the restoration of a freight absorption in the price of steel, New England's metal-working industry is at a disadvantage due to lack of its own integrated mill. The need for raw material in ample supply and at a cheaper price is almost apparent. To the people in industry in New England, it looms as an absolute necessity.

We have in New England an active New England Council in which is represented a large portion of the region's more important industrial companies as well as its banks and other business concerns. The Council began preliminary work on its steel project in 1946. This work led to the organization in July 1948 of a steel committee to consider the problem which I have just briefly outlined. The council and later its steel committee worked quietly and earnestly for over three years developing statistical information with respect to the requirements of our metal-working industry and considered what would be required to have established in New England an integrated steel mill to meet that requirement.

The committee found that the metal-working industries were the fastest growing industries in New England, having accounted for nearly three-quarters of the growth in employment in the area since prewar. It also found that New England was consuming an increasing proportion of the nation's output of steel, a finding recently confirmed by the National Industrial Conference Board, which reported that New England's share of the national use increased from 3.1 per cent in 1937 to 4.4 per cent in 1947-48. Use by New England, New York, and New Jersey combined, roughly the market area for a New England mill, grew from 11.2

per cent of the national total to 13.2 per cent in the same period.

The committee found further that the trend of steel capacity was toward the market and that this trend was helped by the existence of surplus scrap in market areas without much productive capacity. New England is such an area and has a surplus of scrap ample to supply a mill of the type contemplated.

It found further that the source of the industry's iron ore was shifting toward the Atlantic basin, and investigated the new discoveries in Labrador-Quebec, Venezuela, Brazil, West Africa, and other places. This, I am sure, is a subject already familiar to you.

These are a few of the factors taken into consideration by a very earnest group of business men in promoting the proposition to establish an integrated mill in New England.

The steel committee of The New England Council hardly considered the possibility of building and operating an independently owned mill. Their only thought, until recently, about the establishment of the mill was that some major operating company already in the business would become interested in building and operating the proposed mill. This matter was discussed with many of the presently existing steel companies.

At this point now, I want to digress just enough from what I mentioned in the beginning to discuss briefly some of the misconceptions that have arisen about this proposed mill. In the first place, no economic enterprise of the magnitude of this proposed mill can be sponsored and promoted without having some impact on the political life of the region. It is, therefore, only natural that people charged with responsibility of their public office (or politicians if you wish to refer to them as such) should become interested in the enterprise. They would, in fact, be derelict of their duty if they did not. It does, however, inject a factor into the whole proposition which was not considered by the sponsoring group within the New England Council. The governors, senators and representatives of the New England States have discussed this matter in public, attempting in their own way, to promote the project and more specifically to promote it for the benefit of their own locality. I suppose, because of the attendant publicity that there are many who have seen or heard only that phase of the operation and, therefore, consider it as a politician's pipe dream.

The very magnitude of the enterprise does make it an ambitious program. That, in itself, should not condemn it as an impossible program if it is well-conceived and well-founded, and part and parcel of our system of free enterprise. It presents a challenge to New England enterprise and should be respected elsewhere.

The reference to this enterprise as a springboard to the nationalization of the steel industry is not well-founded. I can understand the fear on the part of some people who refer to it in that manner, and under certain circumstances, I can see how that would be possible. I can assure you, however, that in the minds of the people who are presently responsible for the sponsoring of this mill that is the furthest from their thoughts. In order for this mill to be such a tool, it seems to me that it would have to be federally-owned and operated, and while I cannot speak for the federal government, I can speak for the sponsors of this mill, and there is absolutely no such intention on the part of any single individual presently engaged in the development of this project to have it become anything but a privately owned and managed business.

This same reason applies to the references that have been made to the mill as a socialistic venture. Unless it was state or federal-owned and operated, I cannot see how it could be socialistic.

Insofar as it is a threat to the New England market of the present steel companies, certainly that is not denied. We intend that it should be such because without competition of this kind the large and important metal-working industry in New England is threatened by inadequate supply and high cost. However, if any present steel company is interested in protecting their New England market, the sponsoring group in New England would welcome a proposition from any such company for building and operating a mill in New England.

I hope that in this digression I have explained briefly and adequately the basis of some of the criticism directed toward this proposed mill. A large part of it is based on lack of information, or possession of wrong information, on the part of some of its critics. I am assuming, therefore, that it is of more interest to this group to discuss the reasons why we in New England consider it essential that such a mill be constructed, and further, the steps which we have taken to bring about its realization.

I have already discussed the actual conditions in New England which brought about the consideration of this proposition within The New England Council. After a great deal of work had been done by the steel committee in committee fashion, it was decided that to proceed with its work more effectively it should be organized in corporate form. To this end, it obtained a corporate charter in January 1950 and organized the New England Steel Development Corp. All of the common stock of this corporation is presently held by a member of The New England Council as a designee for the council. The present board of directors in addition to myself are:

Frederick S. Blackall, Jr., president and treasurer, The Taft-Pierce Manufacturing Co., Woonsocket, R.I.; Dr. Alfred C. Neal, vice president and director of reSearch, Federal Reserve Bank of Boston, Boston, Mass.; Waldo W. Clarke, engineer-secretary, Commissioners of Steamship Terminals, New London, Conn.; Richard L. Bowditch, president, C. H. Sprague & Son Co., Boston, Mass.

All of them are New England business men. Its present officers are: Clifford S. Strike, president; Dudley Harmon, treasurer; C. E. Whitney, secretary; Frank J. McClean, assistant secretary. All of these men are presently engaged in other businesses in New England.

I mentioned before that a great deal of research on this subject had been accomplished by the steel committee and this information was turned over to the New England Steel Development Corp. for its use. As a part of this research, it seemed evident that the most likely location in New England for the proposed mill would be New London, Connecticut. Relying on this information, the first order of business by the New England

Steel Development Corp. was to conclude a contract with the Connecticut Commissioners of Steamship Terminals to conduct a market survey of the area which could be served by a mill located in New London to determine whether or not in fact a market existed which could profitably support a mill at this location. Also based on previous research, it was tentatively decided, and made a basis for the market research, that the size of the mill, if built, should be approximately one of 1,000,000 ingot tons per annum. Its proposed size will be reconsidered after the market survey.

The New England Steel Development Corp. consulted with established engineering firms and finally selected the firm of Coverdale & Colpitts in New York to make this market survey. That survey is presently in progress and should be completed within about two months.

In conducting this survey, the engineers are charged with developing their facts and figures based on a normal or peacetime economy. This, of course, will be very difficult to do. It will be just as difficult as to determine what in the foreseeable future is going to be a normal or peacetime (and that should almost be in quotes) economy. However, that is our basis and it will be fundamental to our future decisions. The results of this market survey will be made available to present steel companies who might want to reconsider the possibility of their building and operating a steel mill in the region. If, however, at that time, no steel company is interested, then we must consider the possibility of organizing an independent steel company for the purpose of building and operating such a plant. I know that I have said it before, but I am repeating it now for emphasis, that those of us in New England who are interested in seeing a steel mill built would prefer that it be built by a present operating company rather than by a new and independent one. We are, however, determined that if our market survey indicates favorable conditions, we will do all within our power to see that a mill is built and operated.

We recognize the enormous cost entailed in building an integrated steel mill of this size. We recognize, too, what it would mean for any present company to spend that kind of money at a brand new location as against spending an equal amount of money to improve and enlarge their present facilities.

If, though, it is necessary to accomplish our purpose by establishing an independent company, it is not impossible for New England and others to raise sufficient equity money to organize a company for this purpose, and based on preliminary discussions with important lending institutions, it is my opinion that senior money can be made available. This is not a matter which we have passed over lightly. It is one that has been discussed in considerable detail with business concerns and financial institutions capable of doing the financing under certain circumstances. There is a great deal of work ahead, if it is to be accomplished in this manner, but I am merely saying, at this time, that it is not impossible.

All of my discussion so far has been without any consideration to the present or the possible enlarged economy based on wartime conditions. This situation has not been neglected in our thinking. If, in fact, additional steel capacity is required for war purposes and if it is so ordered by proper government agencies and if New England is chosen as a location, we would be glad to discuss the matter at the proper time and place. In considering a Government program for expanding steel capacity in New England to meet defense needs, we will be guided by the purposes and practices of the steel industry during the last war. Like the steel industry, we would have no intention of deviating from our main purpose and that is to have such a mill managed by private enterprise and turned over to private ownership. We are presently determined that this goal of private ownership and management will be reached.

There has been much discussion in both official and private circles of the construction of new steel plants and the decentralization of the steel industry. Dispersal has been advocated in aid of national defense and sustained as an economic advantage in marketing. Both national defense and economical delivery are served by such moves, and we have seen the fruit of this thinking in new steel plants constructed during or since the last war in Utah, California, Texas and elsewhere. That this movement will continue can hardly be doubted, and, in fact, continues with the announcement of a new plant on the Delaware River.

In any such decentralization and location of steel plants near their markets, the case for New England is self-evident. New England is the largest area of demand in the United States that does not possess one or more integrated steel plants within its boundries. It cannot be expected within the foreseeable future that freight rates, by rail or truck, will come down. The only alternative for New England steel users is to have a local source of steel or to suffer high costs and uncertain supplies, disadvantages which endanger the future of our fast-growing metal-working industries. The war's demands for new steel capacity only accelerates the process which was already under way. It is a war essential that New England's industries, which in World War II handled about 9 per cent of all government contracts, can carry their part of the new burden. The New England steel plant was coming anyway; we are convinced that with the war it will come faster.

Annual Spring Conference

DETROIT, MICHIGAN

HOTEL STATLER APRIL 30, MAY 1, 1951

CHILE BUILDS A NEW MERCHANT MILL

By E. C. PETERSON
Birdsboro Steel Foundry and Machine Co.
Birdsboro, Pa.

. . . . with the installation of this mill, Chile will produce some of the steel products which it previously had to import . . . .

▲ MOST foreign countries, seeking to increase their industrial potential, and especially their steel production, are coming to the U. S. to learn the methods by which steel is produced in such quantity and at such low cost as to make it freely available to our great industrial plant. The information has been made available, but, in the case of rolling mill equipment, at least, a large problem has remained unsolved. To get low cost of production, U. S. mills have gone to high tonnage units with a maximum of mechanization. These mills have required large tonnage orders to operate economically, and each has been adaptable to a single class of product. With a consuming market of 130,000,000 people, enjoying a high average standard of living-such units have found wide application. But most foreign markets consume only a small fraction of the quantities of rolled steel products used in this country, and high-tonnage specialty mills, always very costly to install, would operate only a few months a year to satisfy the demand for their products.

A relatively small South American country has undertaken, since the war, to construct an integrated steel plant. In order to solve the problem mentioned above, a finishing mill has been developed and manufactured for them by our company in conjunction with H. A. Brassert and Co. and Koppers Co. consultants, capable of relatively high tonnage production, with a minimum of hand labor, and a variety of product that would normally be produced on three specialty mills. A diagrammatic layout of this mill is shown in Figure 1.

A general view of the mill is shown in Figure 2. In the upper right hand corner are shown the 14-in. continuous stands. In the center are the 14-in. and 12-in. cross country mills with tables and automatic transfers and a skew table. Repeaters are used for rolling both rods and flats, and the flat repeaters are shown in place. The cooling bed is shown in the upper left corner, and to its left the skelp coiling and handling equipment. In the left center is the six-stand continuous rod mill and in the left foreground are the four rod coilers arranged for automatic operation and discharging on a conveyor at the left. The cobble baller is shown in the foreground.

The first development in bar mills beyond the simple in-line mills, was the so-called "Belgian Mill," usually with a 16 or 18-in. 3-high roughing mill, and a four or five-stand 12-in. 3-high finishing mill. Through all the years of mill development, this arrangement has remained the most adaptable to production of a wide variety of products. The arrangement of the presently-described mill has been made around the standard "Belgian Mill," as shown in Figure 3. An 18-in. rougher, three 14-in. and two 12-in. stands are shown in heavy line.

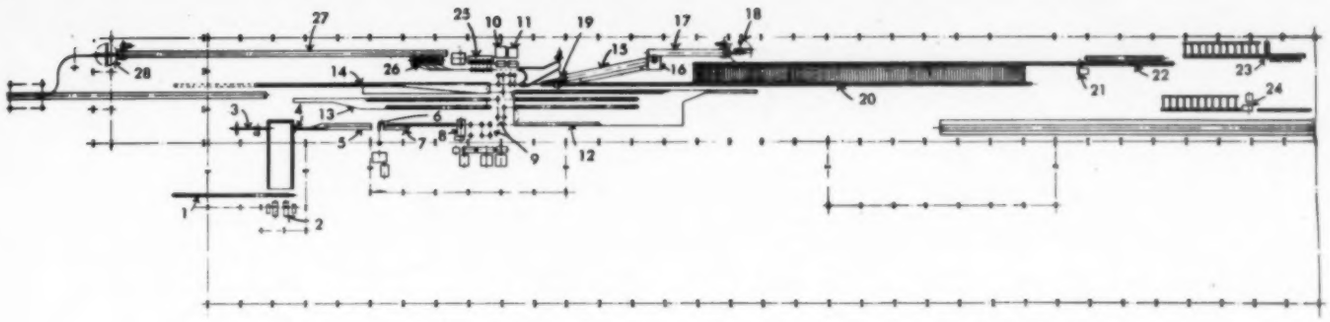
It is usual, on the Belgian Mill rougher, to take five or seven passes. By reducing this number to three or five, one set of rolls can carry passes for a wider variety of products, and production of the rougher can be greatly increased.

Two 14-in. 2-high stands between the rougher and the finishing stands, as shown in Figure 4, replace the passes lost on the 18-in. mill. A vertical edging mill is also shown, for edging flat products.

To facilitate mechanical handling in the finishing mill, all stands are 2-high, and passes are generally limited to one in each stand. To make up additional passes required for $\frac{3}{8}$-in. round, for strip and skelp, and for the rod mill, two 10-in. continuous stands are located after the 12-in. finishing mill.

Also shown in heavy line on Figure 4 is the six-stand continuous mill for finishing rods.

On these various mill combinations, it is planned to produce the following products. From $2\frac{1}{4}$, 3, 4 and



1 furnace charging table
2 furnace pusher
3 furnace billet ejector
4 furnace discharge pinch rolls
5 18" approach table & transfer
6 18" three-high two speed mill
7 split tilting table with automatic transfer
8 vertical edger
9 5-stand 14" mill
10 2-stand 12" mill
11 2-stand 10" mill with repeater
12 runout tables, transfers, repeaters, etc.
13 runout tables, transfers, repeaters, etc.
14 skew table
15 strip vibrator and conveyor
16 strip coiler
17 strip coil conveyor
18 strip coil bundle holder
19 flying shear
20 notch & flat bar cooling bed
21 cold shear
22 shear table, gauge, cradles & scale
23 cold saw with loading skids, tables, gauge & cradles
24 straightener with loading skids & tables
25 6-stand (10" cont. rod mill)
26 rod coilers
27 coil conveyor & unloader
28 coil bundle handle

Figure 1 — Layout of 18-14-12-10 in. combination rod, merchant, structural and narrow strip mill

5-in. square billets, merchant bars equivalent to $\frac{3}{8}$-in. diameter to 2-in. diameter rounds, as shown on Figure 5. From $2\frac{1}{4}$, 3, 4-in. square and $5\frac{1}{2}$ x 4-in. rectangular billets, small structurals equivalent to $\frac{3}{4}$ x $\frac{3}{4}$ x $\frac{1}{8}$-in. angles to 3 x 3 x $\frac{1}{2}$-in. angles, also as shown on Figure 5. From $2\frac{1}{4}$, 3 and 4-in. square billets and slabs from 3 to 4-in. thick and 4 to $9\frac{1}{2}$-in. wide flats, skelp and narrow strip up to 10-in. wide and down to 0.102-in. thick, as shown on Figure 6. From $2\frac{1}{4}$-in. billets, rod from No. 5 up to $\frac{5}{16}$-in. as shown on Figure 7.

Space has also been left available, and the roughing and continuous stands have been so arranged as to make practical the addition of continuous finishing stands in the future, in case a continuous strip mill is required.

The furnace is constructed with a runin table arranged for end charging, and a double furnace pusher which can be mechanically interlocked to push 15-ft billets or can be separated to push two lines of shorter billets.

The 18-in. roughing mill approach table includes a hydraulically operated disappearing dog transfer for pulling over the heavy slabs which are used for rolling flats and skelp. The back side of this 18-in. mill stand is equipped with a hydraulically operated tilting table and automatic dragover to move the bar from pass to pass. To the right of the tilting table is a stationary non-tilting runout table which facilitates the rolling of more than one bar at a time in this stand.

Figure 8 shows the approach table to the 14-in. continuous mill. This table provides two sets of aprons and troughs, either of which can be placed in position by operating the handwheel shown at the right of the table. One set of aprons and troughs shown in position on the table incorporates an automatic switch for feeding four lines of rod mill passes and the other set of aprons and side guards shown to the left of the table is used for slabs and billets for rolling flats, structurals, and merchant bar. Shown just beyond the table is the vertical edging stand, and beyond it the 14-in. continuous intermediate mill stands.

Figure 9 is a general view of the cross country 14-in. and 12-in. mills. All of the mill stands have totally enclosed worm operated screwdowns with a hand wheel

Figure 2 — Photograph shows a general view of the mill outlined in Figure 1.

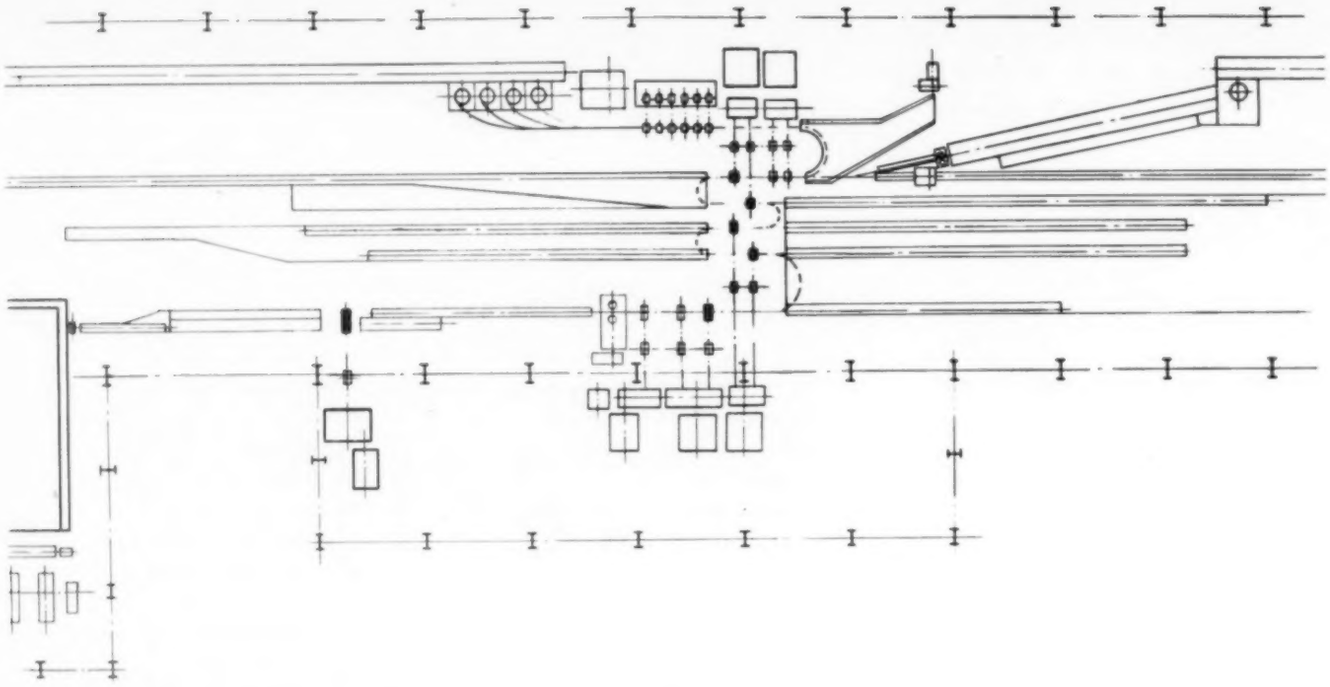
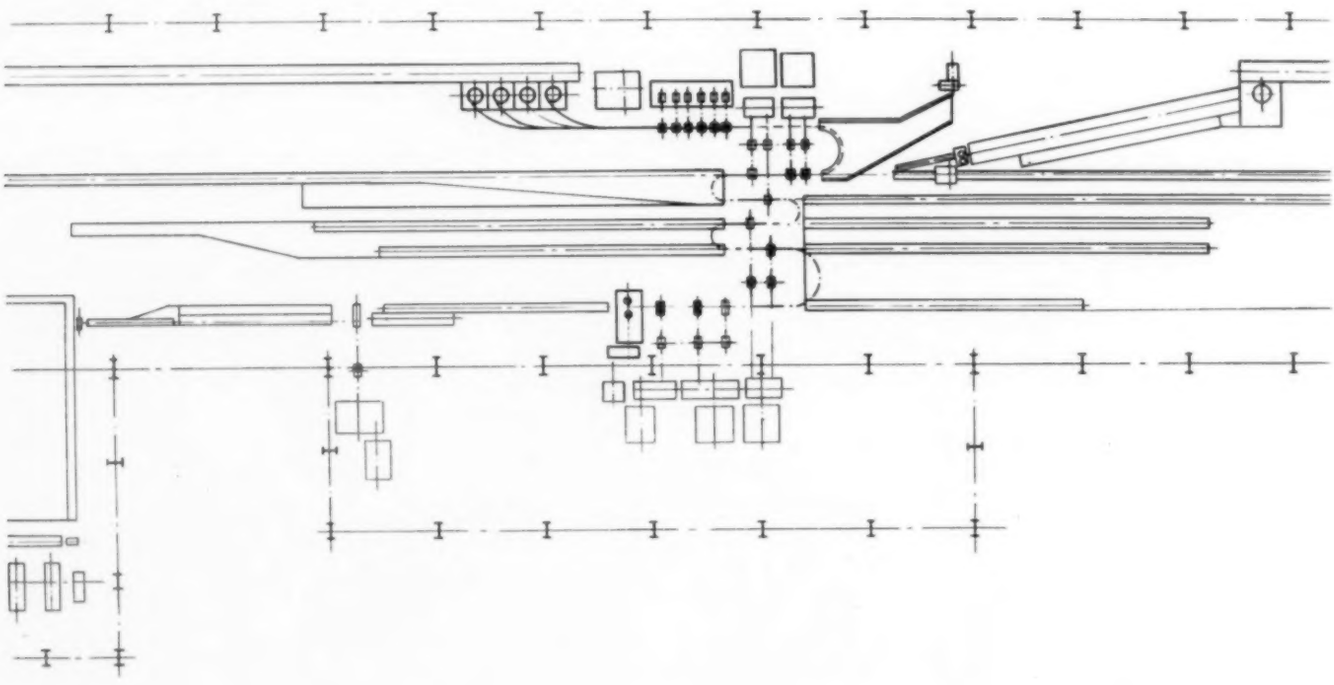


Figure 3 — The mill arrangement was made around a standard Belgian mill.

and clutch for operation. They have bottom roll wedge adjustment and the window clamps for both sides of the housings are controlled from the operating side. Thus, all roll adjustments, vertically and horizontally, can be made from the operating side. The housings also have a heavy shear pin arranged for joining the caps to the housing posts, giving the rigidity of a solid housing combined with simplicity in roll changing as the caps may be tilted back on one side and need never be removed from the housings. The high speed flying shear for the cooling bed is shown in the background with the cooling bed approach table to its right, and the outlet for flat rolled material beyond. This flying shear is capable of cutting material to cooling bed lengths at speeds up to 1800 fpm. The other end of the flat rolled material outlet is shown in Figure 10. The skelp or flat is twisted on edge after leaving the mill, and is vibrated onto a traveling apron conveyor. As the front end approaches the end of the conveyor, an operator pulls it into a vertical crop shear, where the end is cropped,

Figure 4 — The two 14-in., 2-high stands between the rougher and finishing stands replace the passes lost on the 18-in. mill.



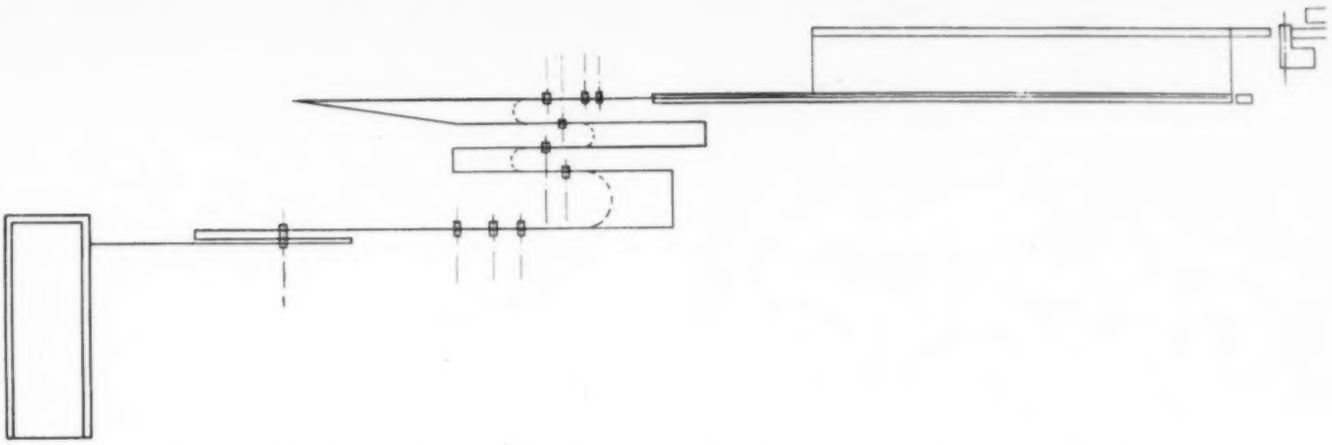


Figure 5 — Production of square and rectangular billets, and small angles is shown here.

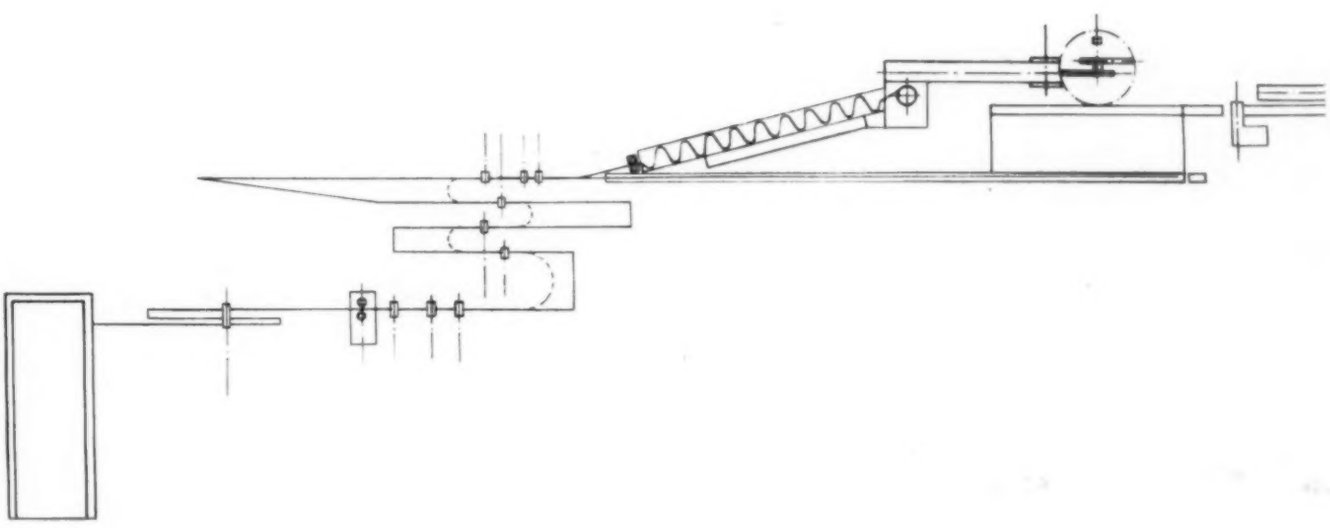


Figure 6 — The production of skelp and narrow strip is shown by the diagram.

Figure 7 — Production of rod is given in this diagram.

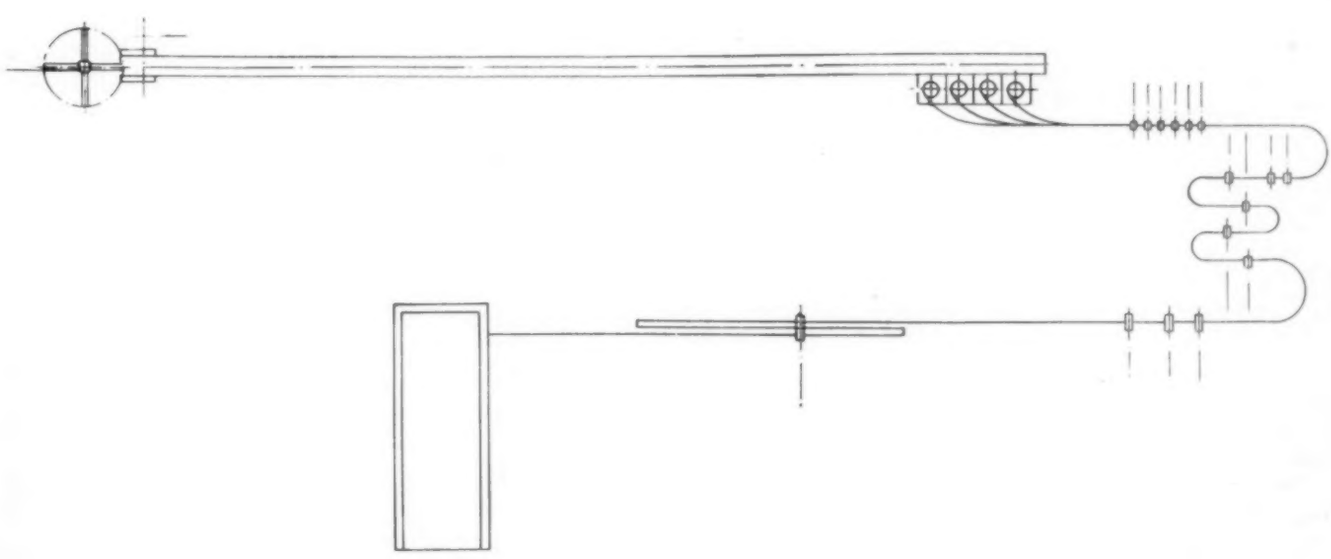
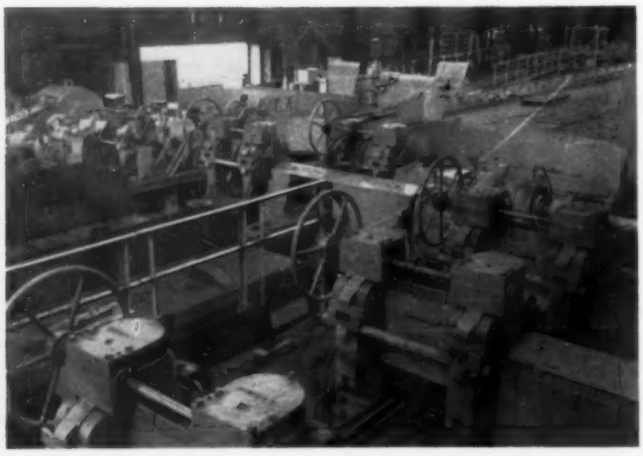


Figure 8 — Approach table to the 14-in. continuous mill.

Figure 9 — The 14-in. and 12-in. mills are of the cross country design.



and then pulls it through a set of back tension rolls and inserts it into a vertical spindle coiler. After the coil is made, it is mechanically transferred to the conveyor table shown. Rollers are provided to prevent damage to the edge of the material. At the end of the conveyor is an automatic unloader which transfers the coils to the coil bundle holder. After a number of coils have been placed on this holder, it is rotated 180 degrees, making a new loading arm available and presenting the assembled bundle for removal by crane or fork truck.

The merchant bar and structural cooling bed is shown in Figure 11. The runin table, with lifting aprons to brake the material immediately before kick-off, is shown on the right. The bars drop into a straightening notch shown below the runin table, and from here they are transferred by lifting plungers onto the cooling bed proper. This bed consists of heavy bars, machined throughout, and accurately aligned to provide commercially straight bars direct from the bed. Each bar has a notched and flat surface, either of which can be placed in operating position by a motor operated drive. Notched surfaces are used for merchant bar and narrow flats and the flat surfaces for wide flats and structurals. Flats up to 10-in. wide can be handled by this bed. The bars are advanced from notch to notch by a shuffling motion between alternate bars, and the drive is so arranged that the individual bars are balanced against each other, neutralizing the weight of the bed, and making for smooth and rapid operation. At the left is shown the shuffle bars for assembling cooled bars on the shear approach table. The shear approach table is also shown, as well as the cold bar shear at the end of the 250-ft long bed.

A small structural straightener of the overhung type is used for the light structural material. This machine has vertical adjustment of all top rolls and axial adjustment of all bottom rolls. A cold saw for cutting small orders was also furnished. This unit has an automatic hydraulic clamp which precedes the saw blade and holds the material to be cut against an anvil until the cut is completed. Feed of the saw is also hydraulic and is freely adjustable. The saw and straightener will both be placed in the finishing end of the mill building.

In order to supply raw material for the merchant mill, a 32-in. blooming mill was also supplied. This mill will handle square ingots from 14 x 14-in. to 23½ x 23½-in., and slab ingots up to 16 x 27-in., and will produce billets down to 4 x 4-in., slabs up to 30-in. wide, and beam blanks for 18-in. maximum beams, the latter to be produced on a proposed future structural and rail mill.

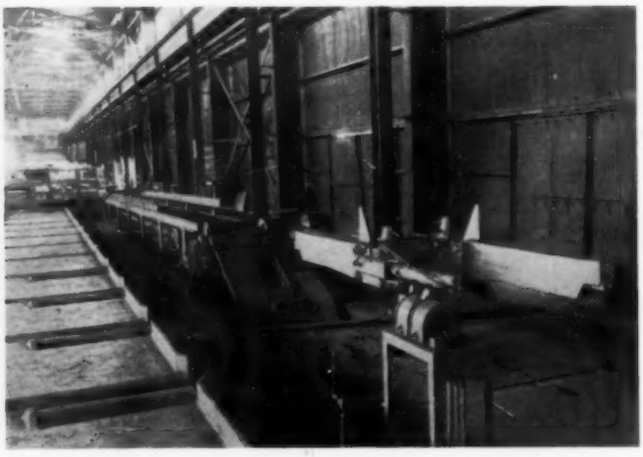


Figure 10 — Skelp or flat product is twisted on edge after leaving the mill and vibrated onto a traveling apron conveyor.

Figure 11 — Cooling bed for merchant bars and structural sections.

New Bar Production Facilities

at

BETHLEHEM'S LACKAWANNA PLANT

. . . . the continuous bar mill is unexcelled for producing large tonnages of quality material within certain ranges . . . .

By GEORGE A. HENDERSON
Superintendent of Mills
Bethlehem Steel Co.
Lackawanna, N. Y.

▲ TO modernize the bar production facilities at the Lackawanna, N. Y., plant, Bethlehem Steel Co. has put into operation a new continuous, high speed, 10-in. merchant bar mill adjacent to the 12-in. bar mill on the Hamburg Turnpike, Woodlawn.

When the 12-in. mill was built at this location in 1940, it was recognized that the arrangement of a series of mills in one area, with a centralized billet storage and preparation yard and common finishing and shipping departments represented the most efficient operation condition. The two mills with all auxiliaries are known as the Bar Mills Division.

Although some increase in capacity has been attained by the changeover, the primary objective was to improve operating efficiency and better the quality of the product. With the new facilities, the Lackawanna plant is now in a position to handle every type and grade of bars required by the aircraft, automobile, agricultural-implement and other industries in the Lake region, New England, Northern New York and the Upper Mississippi Valley.

In the design of both mills, emphasis was placed on the following features, all designed to improve the quality of the product: careful control of all heating operations, from soaking pits to bar mill furnaces; surface preparation of billets, preceded by complete skinning of blooms in the hot scarfing machine; design of guides and loopers to avoid scratching of bars between passes; elimination of twisting and deflections of billets and bars in rolling mills by use of alternate horizontal and vertical stands; high rolling speeds to minimize the temperature drop, thus maintaining uniform section in the finished products, with reduced scaling and decarburization; and adequate facilities for controlled cooling and the latest equipment for the heat treatment of bars both in coils and in straight lengths.

BILLET MILLS

In rolling a quality product, careful attention must be given to the production of the billets from which the bars are rerolled. Essential requisites are good heating; continuous scarfing of high quality steel in the bloom stage; elimination of twist between stands, which has a tendency to open seams and small surface cavities, and finally, proper cooling and surface preparation of billets.

In line with the consolidation of the bar mills, practically the entire load of billets for bar production was transferred to the reversing 40-in. blooming mill and the continuous 30 and 21-in. billet mills.

To equip the 40–30–21-in. mill combination to handle the total billet production for the bar mills, including alloy and special grades, many additions and changes were required. Proper ingot heating has been obtained by adding three 5-hole blocks of 20 ft × 7 ft 6 in. × 11 ft 6 in. soaking pits at the 40-in. bloomer.

A continuous hot scarfing machine was installed between the delivery side of the 40-in. mill and the hot bloom shear. This machine removes a thin layer of metal from the entire surface of the bloom, thus eliminating much work in the subsequent billet preparation. By doing the major part of the scarfing in the bloom stage, higher yields from billets to bars are also attained.

In the 30-in., 6-stand, continuous billet mill following the 40-in. bloomer; stands No. 1, 3 and 5 have been replaced by the latest design of horizontally adjustable vertical stands, to eliminate twisting of the billets between passes. These vertical stands are capable of performing the same amount of work on the section as the horizontal stands. Another important improvement is the installation of new bed plates under the three horizontal stands, to make them adjustable horizontally for the full width of the mill, thus permitting alinement of the roll passes in all stands to a definite line of rolling. Alterations were also made in the horizontal stands to increase the speed of the screwdowns.

The 30-in. mill rolls 7 × 6, 6 × 6, 6 × 5, 6 × 4, 5 × 5, 5 × 4 and 4 × 4-in. billets in lengths varying from 6 to 30 ft. A 60-in. hot saw has been installed, in addition to the existing 600-ton slab and billet shear, to cut or shear billets to the customers' requirements.

The existing 15-ft wide cooling beds have been lengthened to 130 ft to provide additional cooling time before the billets are discharged into cradles at the end of the beds. The two beds can be coupled together to operate as a single unit to handle billets over 15 ft and up to 30 ft long.

Directly in line with the 30-in. mill is a 6-stand 21-in.

Figure 1 — Three 5-hole soaking pits were added to handle the billet production for the bar mills.

billet mill, producing 2½ × 2½ and 4 × 4-in. billets in lengths of from 9 to 30 ft. No changes have been made in the mill proper, except for the installation of a new steam operated flying shear at the exit of the last stand, to improve the shear cut and to provide flexibility in the cut lengths of billets for the trade and for rerolling. Improved cooling has also been attained by extending the two existing cooling beds to 158 ft, almost twice their former length. In addition, a third bed, also 158 ft long, has been added. All beds are 30 ft wide.

A decelerating assembly table has been installed immediately ahead of the cooling beds to assemble sheared billets into ingot or bloom groups before they run out on the transfer tables.

The layout of the mill is such that the controlled cooling facilities of the near-by rail mill are available for special grades of billets. Thus the tender alloy steels are taken directly from the shear or hot saw via crane and transfer to the controlled cooling furnaces, while the common grades are handled on the revised cooling beds.

The billets from the cooling beds of both the 30 and 21-in. mills discharge into an adjacent building, where they are given additional surface preparation as required before shipping to the trade, or before rerolling at the bar mills. Billets may also be transferred by rail without further preparation, to the billet preparation and storage buildings at the new bar mills division, where facilities are also available to give the billets surface preparation, if necessary.

BILLET PREPARATION

Billets requiring further preparation are first pickled in hot, dilute sulphuric acid, rinsed in cold water, and finally scarfed or chipped, as required. Skids for the scarfing and chipping beds are laid on the floor and are spaced to accommodate the different lengths of billets.

Acetylene, oxygen and compressed air are piped to the beds, and every possible precaution has been taken to insure safe and efficient handling of the gases. Acetylene and oxygen are delivered from central stations within the plant and are reduced to the proper line pressure.

Electric transfer cars are used for moving the prepared billets to storage areas and the mill reheating furnaces.

10-IN. CONTINUOUS MILL

The rated capacity of the mill is 25,000 tons per month, in the following types and sizes of bars:

Rounds	½ to 1 9/16 in.
Squares	½ to 1½ in.
Flats	1 × ¼ in. to 5 × 5/16 in.
Hexagons	9/16 to 1 9/16 in.
Auto flat springs	1¾ to 4 in. wide
Reinforcing	½ to 1¼ in.
Angles	1 × 1 in. to 2 × 2 in.

The mill rolls two billet sizes: 2½ × 2½ in. and 4 × 4 in.; all in 30 ft lengths.

Billets from storage, in 10 to 15 ton lifts, are placed on loading skids of the walking beam type, for mechanical transfer to a furnace conveyor, 105 ft long, with 15-in. diameter rollers driven through fully enclosed bevel gears. A charging buggy at the end of the conveyor is used to push the billets in the heating furnace in front of an electrically operated cross pusher.

As a billet is fed at the upper end of the furnace, the entire row of billets is pushed down the inclined hearth, toward the hot end. The billets are thus heated gradually and uniformly until they finally reach the desired rolling temperature. One by one, as they are needed they are then pushed out at the discharge end of the furnace.

The heating furnace is of the recuperative type, with suspended roof, and has an effective hearth area of 32 × 55 ft. It has an hourly heating capacity of up to 75 tons of billets, depending upon the grade and size of product being rolled.

A mixture of coke oven and blast furnace gas of 400 Btu per cu ft, or bunker C fuel is used, and the furnace is fired with 11 burners evenly spaced across the discharge end about 40 in. above the hearth.

Figure 2 — On the 30-in., 6-stand continuous billet mill the latest design of horizontally adjustable vertical stands were installed for stands No. 1, 3 and 5. New bed plates were also installed under the three horizontal stands.

Figure 3 — After the 21-in. mill, a steam operated flying shear is installed.

A furnace control panel, housed in a steel and glass building, consists of the following instruments and regulators for maintaining proper furnace conditions for the most efficient and uniform heating of the billets: fuel air ratio regulator, a recording control pyrometer for measuring roof temperature which automatically controls fuel input to the furnace, a furnace pressure regulator for maintaining proper furnace draft, recording flow meters for gas, oil and combustion air; and indicating pyrometer to regulate the preheated air temperature to the furnace burners and a three-record recording pyrometer which measures waste gas temperatures leaving the furnace and leaving the recuperator, and preheated air temperature.

The combustion air is preheated to 500 and 600 F, in a two-pass recuperator equipped with silicon carbide tubes through which the furnace gases pass on their way to a 75 ft ejector stack. The temperature measurements surrounding this recuperator are recorded on the three-record pyrometer previously mentioned, which is located on the control board.

For use in the heating of alloy steels of critical analysis, an outlet for the products of combustion has been provided on the furnace, about two-thirds back from the firing end, in addition to the regular outlet at the feed end. In general, when alloy steels are rolled, the volume of gases passing through the preheating chamber is regulated to give a billet temperature of 600 to 700 F, at the end of this zone.

The design of the mill is directed toward production of uniform quality bars, with uniform section. This calls for even heating, with good control and rapid rolling. To accomplish this, the bar products are rolled from full length billets (except when rolling coiled bars) and sheared to cooling bed lengths on a rotary disc type shear ahead of the cooling beds. This manner of rolling permits finishing the sections at higher temperatures, improving the quality, and producing uniform section on bar products.

At the discharge end of the furnace is an up-and-down cut shear for shearing billets to the proper length for the bar products to be coiled. Both the upper and lower knives of this shear are actuated by cranks, and no tilting table is, therefore, required. The approach table of the mill serves as a back shear table.

The mill has 18 stands arranged in 3 major groups: 8 roughing, 4 intermediate and 6 finishing stands. See Table I. Except for the horizontal stands No. 4, 5 and 6, all stands are alternately horizontal and vertical. Each is individually driven by an adjustable speed d-c motor, and are equipped with one-piece roll chocks, using fabric bearings. The delivery speed of the last stand in the finishing mill is about 2400 fpm.

An electrically operated flying crop and cobble shear immediately following the roughing train automatically crops the front end of the bars as delivered from No. 8 stand. The shear is automatically operated through an electrically controlled timing device, to make one cut. The purpose is, as the name implies, to cut or crop the front end of the bar at this location. Ends are cropped to prevent wrecks or damage to rolls in the balance of the train due to ends being cold or distorted. In the event that a cobble occurs in the intermediate or finishing stands, the pulpit operator can start the shear in

Figure 4 — Layout of 10-in. continuous bar mill at the Lackawanna Plant of the Bethlehem Steel Co.

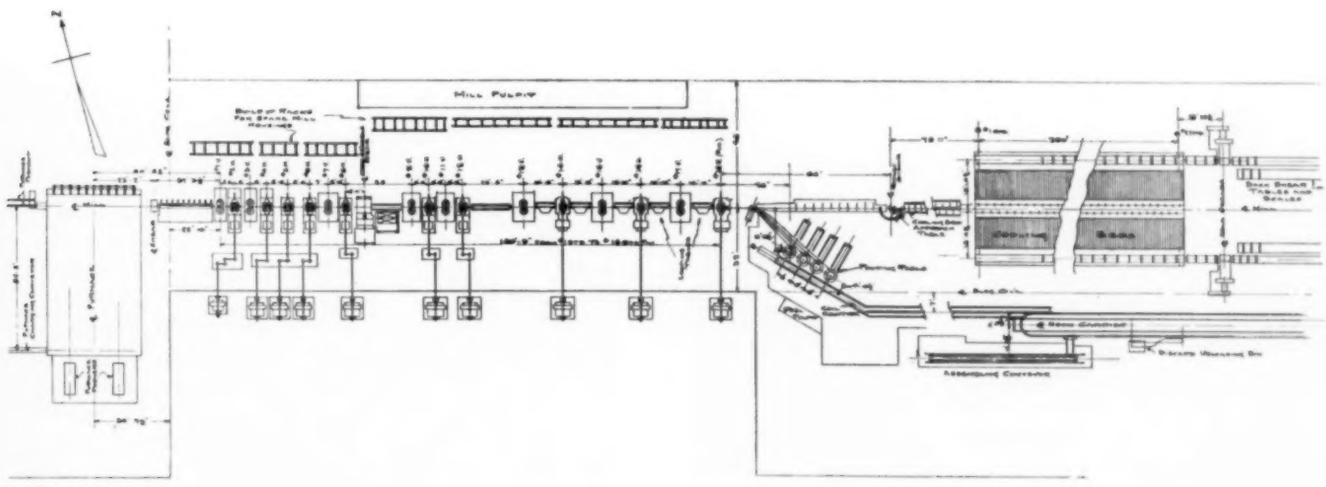


TABLE I

Stand	Motor data			Mill data				
	Hp	Rpm	Speed ratio	Gear ratio	Mill rpm	Normal size roll		Roll speed, fpm
						Diam-in.	Body-in.	
No. 1 Vertical	300	250/980	3.92/1	20.273/1	12.33/48.34	14	15	4.53/177
No. 2	300	250/980	3.92/1	18.092/1	13.82/54.17	14	28	50.7/199
No. 3 Vertical	300	250/980	3.92/1	15.120/1	16.53/64.81	14	15	60.7/238
No. 4	500	125/500	4/1	6.364/1	19.64/78.57	14	28	72.1/288
No. 5	500	125/500	4/1	4.444/1	28.13/112.51	14	28	103/413
No. 6	500	125/500	4/1	3.032/1	41.23/164.91	14	28	151/605
No. 7 Vertical	600	150/540	3.6/1	2.4/1	62.50/225.00	12	20	196/707
No. 8	600	150/540	3.6/1	1.929/1	77.76/279.94	12	24	244/879
No. 9 Vertical	600	200/720	3.6/1	2.179/1	91.79/330.43	12	20	288/1038
No. 10	600	200/720	3.6/1	1.837/1	108.87/391.94	12	24	342/1231
No. 11 Vertical	600	200/720	3.6/1	1.538/1	130.04/468.14	12	20	408/1470
No. 12	600	200/720	3.6/1	1.321/1	151.40/545.04	12	24	475/1711
No. 13 Vertical	600	200/720	3.6/1	1.0667/1	187.49/674.98	10	21	491/1768
No. 14	700	200/680	3.4/1	1/1	200/680	10	21	524/1782
No. 15 Vertical	600	250/825	3.3/1	1.071/1	233.43/770.31	10	21	612/2018
No. 16	700	250/790	3.16/1	1/1	250/790	10	21	655/2070
No. 17 Vertical	600	350/960	2.74/1	1.075/1	325.58/893.02	10	21	853/2340
No. 18	700	350/920	2.63/1	1/1	350/920	10	21	917/2410

continuous motion and cut the steel already in the roughing train into short lengths which fall into the scrap bucket below the floor level.

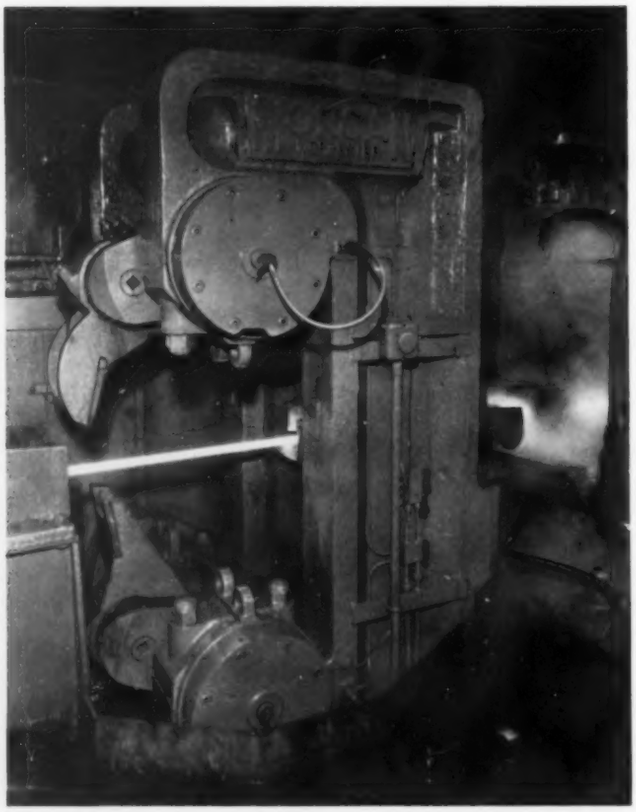
The guide equipment has been designed to include all the recent improvements to prevent scratching the surface of the bars. Straight type entry and delivery guides are used throughout the mill except for the entry guides on stands 6 to 18 inclusive, which have rollers mounted in them to further eliminate scratching.

Provision is made between the six finishing stands for the bars to form loops between stands. Loops can be horizontal or vertical depending on the section being rolled. When rolling rounds, the loop is caused to lie out horizontally on a looping table. As the loop forms it passes over a series of electrical contact points which control the speed of the receiving stand motor drive and thereby automatically keeps the loop under control. When rolling flats or squares the loops are allowed to form by opening the bottom of a trough between stands; these are air operated through electrical controls from the operator's pulpit. The operator controls the speeds of the mill stands when on these sections. The troughs and horizontal looping tables are adjacent and are moved into line of rolling by hydraulic pressure.

All controls for the mill are arranged in a 10 × 125-ft pulpit facing the intermediate and finishing stands.

The major part of the output of the mill is delivered to a double pack annealing cooling bed, reached by a 150-ft approach table. About 60 ft from the last stand is an oscillating rotary-disc shear capable of cutting sections up to and including 1½-in. rounds to cooling bed lengths. An automatic switch beyond this shear directs the cut bars over the table to alternate sides of the bed.

Figure 5 — An electrically operated flying crop and cobble shear crops the front end of the bars as they come from No. 8 stand.



COOLING BEDS

The cooling beds are 390 ft long and 17 ft wide between run-in and run-out tables. In order to aline the bars entering the run-in table of the cooling bed and to keep them perfectly straight prior to the kick-off operation, the individual rollers on the run-in table alongside the bed are flanged at one end, and the face of the roller is slightly tapered toward the flange. To stop the forward travel of the bars on this table, the apron plates are lifted above the table rollers, supporting the entire length of the bars except for the gaps at the table rollers. A series of kick-off arms then sweep the bars sidewise onto an apron of sufficient slope to allow the bars to slide by gravity until they fall into a straightening groove. The resulting impact is sufficient to insure straightness of the bars as they are delivered to the cooling bed proper.

The cooling bed consists of two sections, a primary section for pack-annealing flats, and a secondary section for cooling bars in spaced formation.

When flats are pack-annealed on the primary section they are deposited on edge, with the bar first delivered supported by a counterweighted dog to prevent it from overturning. As a new bar is deposited against the first, the dog yields a distance equal to the thickness of the bar. When the pack reaches the full width of the primary bed, the dog automatically disappears below the surface of the bed. The bars first deposited then slide off onto the secondary section as succeeding bars are delivered to the pack. The width of the primary section is sufficient to insure complete annealing and to give the bars a permanent set before they are delivered to the secondary section.

The secondary bed has racking bars, each bar having two working faces, one straight and one notched. Thus it is possible to operate with a notched bed surface or a flat top surface according to the type of bars rolled. All working faces are carefully machined to prevent scratching and marking of the finished bars. Adjustments to make proper alinement of the grooves are easily made without interrupting the operation of the bed.

To cool all sections in spaced formation, without pack-annealing, the slope of the primary bed is increased to make bars slide into the first notch of the racking bars of the secondary bed, where they move forward a step at a time, as additional bars are delivered. Angles and irregular sections are delivered to the secondary bed in the same manner, and are supported in grooves during cooling, or placed in close or spaced formation on the flat bed surface.

The cooling beds extend to the finishing buildings. At the end of each bed is a runout table and a cold-bar shear with gage and gage stops. The back shear tables are equipped with two sets of cradles, kick-offs and scale.

At the back shear table of the cooling beds is a pulpit which controls the beds, either manually or automatically.

The racking, shuffle bars and run-out table are also controlled from either the cold shear or the hot bed pulpit.

COILING BARS

Bars may also be delivered from the finishing stand to one of four pouring reels. Water-cooled delivery pipes used for this purpose are equipped with special roller guides to hold flats with their major axis in a vertical position during coiling.

The reels are equipped to produce two sizes of coils, the smaller size 25½-in. inside diameter and 40-in. outside diameter, for 300-lb coils and the larger 33½ and 49½ in. for 600-lb coils. Reels have capacity for coiling 1-in. rounds and equivalent rectangular sections, with the larger diameter coils for the heavier sections.

When completed, the coils are transferred horizontally by a motor operated pusher to a continuous conveyor. An automatic switching device directs the bar from one reel to the next between successive rod lengths.

The coil conveyor consists of two sections, section 1 which is about 40 ft long, receives the coils and delivers

Figure 6 — After the last finishing stand of the bar mill, there is an oscillating rotary-disc shear which can direct the cut bars to either side of the cooling bed.

them to an intersection with the second section, which is 280 ft long. At the intersection of the two conveyors, provision has been made for assembling the hot coils on mandrels, if controlled cooling is desired. The mandrels are transferred by crane to an adjacent area in the coil storage building where they are placed under sheet metal hoods for slow cooling.

In the normal rolling schedule, the coils are delivered to the second section and carried along to a point where they are automatically transferred to a hook carrier for further cooling, inspection, trimming and delivery to a coil assembly station. Extra heavy hooks on roller bearings are used to handle the 600-lb coils.

Special air-operated lifting hooks remove the reject coils from the hook carrier, ahead of the automatic discharging mechanism for the prime coils. The prime coils are discharged into a chute permitting them to roll or slide down to an assembly conveyor, so arranged with cradles on an endless chain as to assemble the coiled product in groups of eight. As each coil is deposit-

Figure 7 — The double annealing cooling bed takes the major part of the bar mill product.

Figure 8 — Bars may be delivered from the finishing stand to any one of four pouring reels.

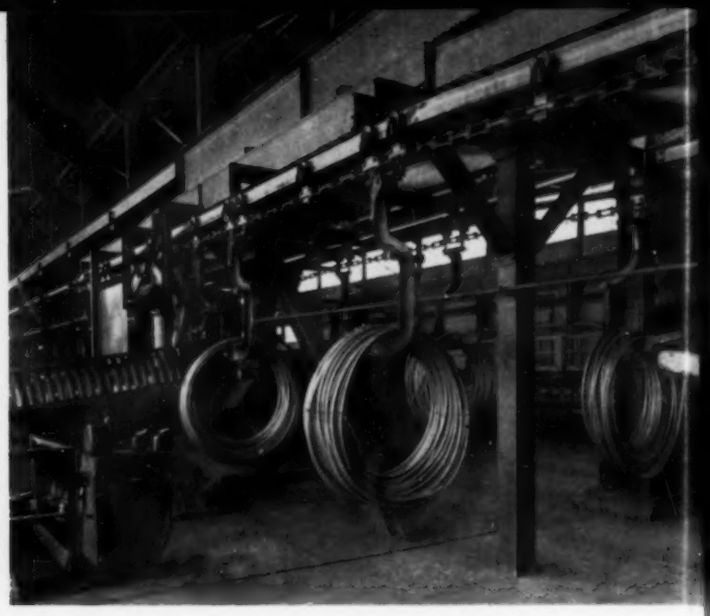


Figure 9 — Coils are automatically transferred to a hook carrier for cooling, inspection and trimming.

ed on the secondary conveyor, the conveyor is moved a distance equal to the thickness of the coil. The coils are closely stacked in each cradle section of the conveyor by means of an air-operated pusher. When a filled cradle section reaches the end of the conveyor, the coils are removed in batches of eight coils from the cradles by means of a hair pin hook suspended from the crane in the coil dock building. The lifts are either placed in storage or loaded directly into railroad cars for shipment.

ANNEALING

Coiled bars to be annealed are taken from the coil storage building by crane to the annealing building with adjacent cleaning house.

Five cylindrical bell-type furnaces with 15 bases are available for the treatment of bars in coils, and four car bottom furnaces, three of the radiant-tube type and one a direct-fired type for the treatment of straight bars.

The bell-type furnaces are equipped with vertical radiant firing tubes of heat resistant alloy, 12 for each furnace, in which is burned a mixture of coke oven and blast furnace gas of 400 Btu, with gas and air at 17 in. of water pressure.

To conform with the best practice in annealing alloy and high carbon materials, the coil furnace bases are equipped with double seals; an inner oil seal and an outer seal of water, with alloy base-covering over the brick work; alloy base castings and alloy inner covers; so that all parts are protected against scaling, and the brickwork is not exposed to the furnace atmosphere.

Dry, sulphur-free "NX" furnace atmosphere gas, containing 93 per cent nitrogen, produced in a unit with an hourly capacity of 3000 cfhr, is circulated under the covers during the annealing cycle. A new type of base fan is used in circulating this deoxidizing gas, operating at a speed of 1750 rpm. This gives excellent distribution of the heat and thus aids in producing uniform physical properties.

A 3-point recording potentiometer provides temperature readings from thermocouples at the top and bottom of the charge, (for program control of the annealing cycle), and from the position adjacent to the firing tubes for high limit control of the furnace temperature.

The radiant tube car bottom furnaces have an available hearth area of 4 × 31 ft and are capable of annealing straight bars in lengths up to 30 ft loaded in cradles with a maximum of 30,000 lb per charge.

Twenty-six burners are arranged in the sidewalls of the furnace; evenly staggered for uniform heating, and six burners on the car itself. They are fired with a mixture of coke oven and blast furnace gas of 400 Btu, at 12 oz pressure, with air at 24 oz pressure. Maximum fuel input is 3,500,000 Btu per hour. Two 2500 cfhr units supply inert furnace atmosphere "NX" gas during the annealing. A sand seal keeps the outside air from coming in contact with the steel.

The furnaces have three zones of combustion control with thermocouples in each zone for automatic program control of the annealing cycle. One of several combinations of heating, soaking or cooling periods may be selected.

The direct fired car bottom furnace has 31 × 6½ ft available hearth area and has a maximum capacity of 60,000 lb of bars. It is designed to fire 20,000 cu ft, 400 Btu gas per hour at 6–8 oz pressure. Like the three other car bottom furnaces, it is designed with three firing zones and is equipped for automatic program control. During the cooling cycle air may be admitted through the burner ports if desired.

The cleaning and baking equipment, housed in a leanto at the end of the annealing building, is of the conventional type with pickling and wash tanks, sulling tank, lime tank and a flash baker. It has a capacity of approximately 200 tons of coils per 24 hours.

BAR FINISHING

Sections requiring further processing are transferred to the finishing and shipping buildings, which contain a reshearing line producing bar lengths for the trade, and various types of round and flat straighteners,

Figure 10 — Five bell type furnaces with 15 bases are available for the heat treatment of the bars in coil form.

Figure 11 — Four car bottom furnaces are available for heat treatment of straight bars.

centerless grinders, straightening machines, oilers, hack saws, scales and a shot blast cleaner.

The present bar division is made up of the following buildings:

1.	Three billet preparation and storage buildings, under one roof, without dividing walls	80 × 850 ft
2.	Furnace building	105 × 300 ft
3.	Mill building, 10-in. mill	100 × 632 ft
	12-in. mill	100 × 632 ft
4.	Motor room, 10-in. mill	45 × 215 ft
	12-in. mill	32 × 175 ft
5.	Coil dock building	70 × 104 ft
6.	Annealing building	175 × 210 ft
7.	Cleaning house	36 × 210 ft
8.	Three finishing and shipping buildings under one roof, without dividing walls, No. 1	105 × 1000 ft
	No. 2 and 3	105 × 1125 ft
9.	Roll and machine shops	50 × 225 ft

With five office and welfare buildings this gives a total area under roof of 835,000 sq ft, or approximately 19 acres.

The main buildings have walls constructed with 8 ft of brick at the bottom and 10 ft wide ventilating doors; and corrugated protected metal and sheet sash along upper section. Roofs are corrugated protected metal with glass monitor the entire length of the buildings. Windows in the walls, as well as in the roof monitors, provide an abundance of daylight everywhere. Floors are concrete, brick or mastic black top, according to locations.

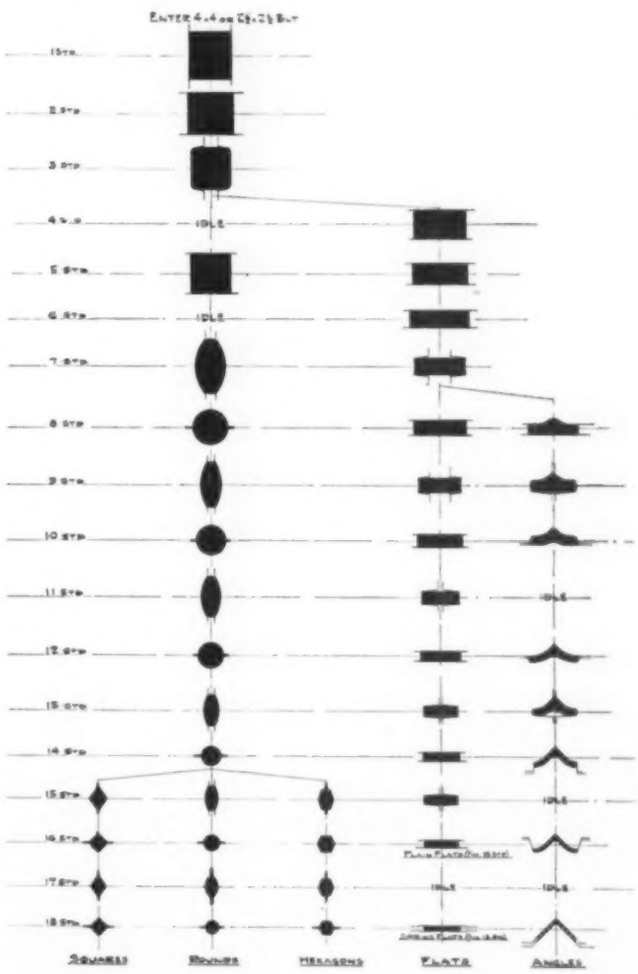
The motor room in the 10-in. mill has glazed tile from floor to roof, with glass blocks in walls instead of windows. The motor room is air conditioned and kept under a slight air pressure. A combination air washer with sprays, rubber plates, and wet cells of 35,000 cfm capacity purifies the outside makeup air for the 10-in. mill motor room.

For the convenience of the workmen, four welfare buildings have been provided at different locations rather than one large central building. These welfare buildings are clean and attractive and equipped with steel lockers, showers, wash basins and toilets.

[*Editor's Note* — This mill has now been in operation for over three years. H. A. Carter, superintendent of the roll department at the Lackawanna plant, gave the following data on the mill at the Pittsburgh Regional meeting of the American Iron and Steel Institute on October 11, 1950.]

"This mill started to operate in May 1947, and for

Figure 12 — Typical layouts of sections rolled on the 10-in. continuous bar mill.



the remaining eight months of that year the mill rolled a total of 75,482 tons. Total operating time was 3,319 hr, 52 per cent of which the mill was down due to various causes, leaving 48 per cent of 1,590 hr of actual rolling time. This is an average of 186.3 tons per eight hour turn, or only 22.7 tons per hour. The number of sections rolled during this period was 466, or an average of 162 tons per section. The yield for the first year was 90.22 per cent, and the record month was December when a total of 17,585 tons were produced.

"It was obvious that the down time during the first eight months was too high, too much time was involved in changing passes and rolls, and, unless orders were large enough, more time was consumed in making changes for a section than was required to roll the order.

"The year 1948 showed considerable improvement and many alterations were made in roll designs and guides to speed up pass changing and eliminate roll changes wherever possible.

"The summary for the year is as follows:

Number of turns rolled	970 7761 hr
Actual rolling hours	4,285 or 55 per cent
Down time hours	3,475 or 45 per cent
Total tons rolled	244,742 tons
Average tons per turn	252.3
Average tons per hour	31.5
Total number of sections rolled	1,376
Average tons per section	178 tons
Yearly yield	91.4 per cent

"In 1948, the mill established a record of 29,541 tons in the month of July. During this month the down time was down to 38 per cent of the total hours and the average tons per turn was 336, an hourly average of 42 tons. Only 73 sections were rolled, an average of 391 tons per section.

"Further improvements were made in 1949.

Number of turns rolled	885
Hours	7,080
Down time hours	3,208 or 45 per cent
Actual rolling hours	3,871 or 55 per cent
Total tons rolled	237,373
Average per turn	268.2
Average per hour	33.5
Number of sections rolled	1,861
Average tons per section	128
Yearly yield	91.06 per cent

"For the first six months of 1950, the mill again showed a steady improvement.

The number of turns rolled	490 3920 hr
Down time hours	1,570 or 40 per cent
Actual rolling hours	2,350 or 60 per cent
Total tons rolled	143,218
Average per turn	272
Average per hour	36.5
Number sections rolled	1,303
Average tons per section	110
6 months average yield	91 per cent

"It is extremely interesting to note that while from 1948 to 1950, the number of sections rolled increased considerably and the tons per section dropped from 178 to 110, the tons per hour increased from 31.5 to 36.5. This shows that with the added experience in changing passes and rolls and the improvements in the operations in general, this completely continuous 10-in. high speed mill could well be expected to produce regularly around 25,000 tons of quality bars each month should business continue on the same basis.

"To facilitate better mill orders, present schedules are so arranged that some sections are rolled in cycles of two months or more.

"The following schedule shows the percentages of each type of section rolled in a typical quarter:

"Second quarter of 1950

Total tons rolled	72,021 tons—avg per hr 35.4	
Rounds	38,744 tons or 53.8	per cent
Flats—nut flats and spring steel	28,366 tons or 39.4	per cent
Hexagons	1,943 tons or 2.7	per cent
Angles	1,099 tons or 1.5	per cent
Squares	1,869 tons or 2.6	per cent
	72,021 tons	100 per cent

"In conclusion, we would like to state that for the making of plain bars such as rounds, squares, flats, hexagons and equal leg angles, this type of mill is highly recommended, both from a quality and a tonnage standpoint."

THE DESIGN OF A NEW OPEN HEARTH SHOP*

▲ A modern steelworks should have not over 12 open hearths of 200 tons capacity each, in one furnace building, for the most efficient results.

The purpose of this paper is to give helpful suggestions to those who would have to build new plants, and the suggestions are based on experience in building large, modern steelworks.

Maximum production per furnace per month can be obtained in a plant limited to six furnaces. The size of furnaces should be determined mainly on the size of orders handled, as large furnaces are economical only for large orders. On the other hand, operations are less flexible with large furnaces. Where blown metal is obtainable, open hearth furnaces could run as high as 550 to 600 tons capacity per heat.

The author discussed numerous other problems of lay-out and equipment, explaining that engineers differed on many details, and that final answers usually depended on capital and land available as well as the kind of steel to be made and the lay-out in relation to existing plants.

*Abstracted from paper of same title presented by H. E. Warren, Jr., Div. Supt., Open Hearth Dept., Homestead District Works, Carnegie-Illinois Steel Corp., at Pittsburgh Regional Technical Meeting of AISI, Oct. 11, 1950.

THE ACTION OF CUTTING FLUIDS IN MACHINERY

. . . . in machining, proper selection of cutting fluids results in reduction in heat generation, reduction in friction, better surface finish, and lower temperatures because of cooling action . . . .

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Cincinnati, Ohio

▲ WHAT does a cutting fluid do in the metal cutting process? What, basically, are the functions of a cutting fluid? How does it affect cutting, chip formation, the performance of cutting tools? The finding of answers to such questions as these has been the basis for a continuing major research program by the writer's company for many years. Some of the results of this research, giving answers to such questions as the above, will be set forth here.

Basically, the action of a cutting fluid in machining may be summed up as follows. Heat is the enemy of cutting tools in machining operations. Heat causes tools to fail. While a cutting fluid must perform many functions in practice, its main function is the control of heat in the machining process. A cutting fluid does this in two ways.

1. Straight-forward cooling action, carrying away the heat that is generated in cutting.
2. So-called "lubricating" action (friction reduction), reducing the amount of heat that is generated in cutting.

It is these two basic functions of a cutting fluid that will be discussed.

The fact that "heat is the enemy of cutting tools" is well illustrated by some work done by Schallbroch[1] and others. Figure 1, taken from data obtained by them, shows that tool life is a direct function of cutting temperature, i.e., the temperature of the cutting tool. The interesting thing about the relationship is that, for a very small change in temperature, there is a large change in tool life. For the particular case shown in Figure 1, a drop in temperature of only 50 degrees (700 to 650 C) raises the tool life from about 4 minutes up to about 20 minutes; another 50 degree drop (650 to 600 C) raises tool life from 20 minutes on up to several hours. In other words, small changes in tool temperature can produce tremendous changes in tool life. The importance of the control of heat—tool temperatures—in the cutting process is evident.

As mentioned above, one method by which a cutting fluid controls heat in machining operations is by direct cooling. It is important, therefore, to be able to make direct measurements of the heat transfer properties (direct cooling action) of cutting fluids. An apparatus developed specifically for this purpose is shown in Figure 2. The heart of the apparatus is a small diameter stainless steel tube (hypodermic tubing), designated "A" in the photograph. This tubing is heated by passing a heavy current along it; its own electrical resistance causes it to get hot. The tube is cooled by pumping cutting fluid through it at an accurately metered rate. The temperature of the tube wall is measured with thermocouples attached at intervals along the tube. That temperature, read by any one of the thermocouples, is thus a measure of the ability of the fluid to cool. The lower the temperature, the better the cooling action of the cutting fluid.

The results of a typical investigation made with this apparatus are shown in Figure 3. In these tests, two different types of water-based cutting fluids were studied. As is well known, water has outstanding cooling ability, so that it is of interest to see how that cooling ability is affected when cutting fluids are added. Thus, measurements were made to determine how much hotter the tube ran when cutting fluids were added to water than when pure water alone was used. The temperature scale on the left hand side of the chart of Figure 3 represents such measurements; the higher this temperature, the poorer the cooling ability of the cutting fluid. It is evident from the chart that the presence of any appreciable concentration of oil in water considerably impairs its cooling ability. With oil present in the concentrations normally used in machining, tube temperatures run as much as thirty degrees higher than with plain water. On the other hand, the use of a suitable emulsion of chemical additives in water has little detrimental effect on heat transfer. Here, in the concentrations normally used in machining, the tube temperatures run no more than seven degrees higher than with plain water. It is evident, therefore, that oil is detrimental to good heat transfer and that for maximum cooling ability, oil content in a water-based cutting fluid must be kept as low as possible.

If this is the case, what about the second basic function of a cutting fluid, that of so-called "lubrication", or friction-reduction? Does this not depend on oil, and if so will it not be adversely affected? These are logical questions, but their answer depends on an understanding of the nature of the "lubrication", or friction-reduction, accomplished by cutting fluids in the machining process. Let us look into the nature of this

1. H. Schallbroch, H. Schaumann and R. Wallichs, "Testing for Machinability by Measuring Cutting Temperature and Tool Wear," Vortrage der Hauptversammlung 1938 der Deutschen Gesellschaft fur Mettallkunde, V.D.I. Verlag, pp. 34-38, 1938.

second basic function of any effective cutting fluid, that of cutting down the heat that is produced in machining. In order to do that, we first have to know where the heat comes from in cutting processes. This necessitates a look into the metal cutting process to see what goes on when chips are formed.

Figure 4 is a view of a chip being formed, snapped through the microscope while cutting. The direction of view is along the cutting edge of the tool, looking at it as though it were a planing operation. If chip formation is studied from this point of view, it is soon found that there are two sources of heat generation in the cutting process. They can readily be seen in Figure 4. First of all, there is the deformation of the metal ahead of the cutting tool, to form the chip. That plastic deformation, or shearing of the metal, generates heat and is thus one of the two sources of heat genera-

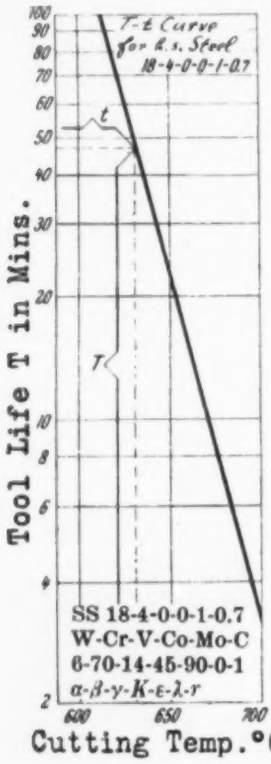


Figure 1 — A very small decrease in tool temperature results in a very large increase in tool life. Data by Schallbroch, Shaumann and Wallichs.

tion. After the chip has been formed by plastic deformation of the metal, it then has to escape by sliding up the tool face. As it does so, it encounters a very considerable amount of frictional resistance. Overcoming that frictional resistance between chip and tool generates additional heat. That is the second source of heat generation in metal cutting. All of the heat produced in machining comes from these two sources—the deformation of the metal and the rubbing friction on the tool face. In rough terms, about 25 per cent of the heat generated in cutting comes from friction between the chip and tool and about 75 per cent comes from the deformation of the metal.

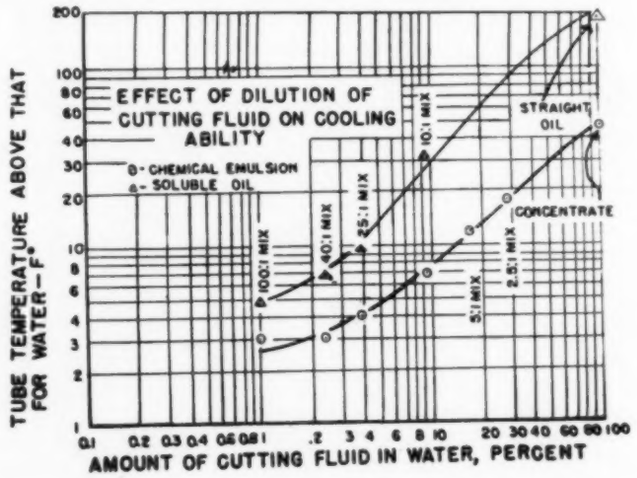
In view of these facts, it is evident that one possible way in which a cutting fluid may reduce the heat generated in machining is by cutting down the rubbing friction between chip and tool. That would be "lubrication" and would, at least, reduce somewhat the 25 per cent portion of heat coming from chip friction.

Figure 2 — The pyrotranmeter provides a direct, sensitive measure of the cooling ability of cutting fluids. Apparatus developed by George Hain.

However, that still leaves the other 75 per cent to worry about; the 75 per cent coming from the deformation of the metal. Is there anything the cutting fluid can do about that? In order to answer this question, it is necessary to look at the deformation process a little more closely and see how it takes place. If that is done, the process is found actually to be quite simple. The chip is formed merely by shear, or slip, or plastic deformation—whatever one wishes to call it—along a plane running from the cutting edge up to the work surface. All the deformation occurs right in that narrow region, which is called the "shear plane". This "shear plane" can be clearly seen in Figure 4. The heat coming from the deformation of the metal in the machining process is produced on that plane.

In Figure 5 the shear plane is shown schematically: here the angle which it makes with the direction of tool travel is designated by the Greek letter "phi". That angle is a variable, depending on a number of conditions. As the shear angle varies, it changes the amount of deformation of the metal and, so, it changes

Figure 3 — The cooling abilities of water-based cutting fluids vary greatly with type and dilution.



the amount of heat produced by that plastic deformation. The way in which this takes place is shown in Figure 6.

As may be seen, if the shear angle is small, then the plane on which the deformation occurs (shear plane), runs out a considerable distance ahead of the tool and the result is that the layer of metal being removed by the tool is deformed into a short, thick chip. Thus, a small shear angle means severe deformation of the metal and, as a result, considerable generation of heat from that source. On the other hand, if the shear angle is large, then, as may be seen, the path of shear is short; this results in a long, thin chip. In such a case, then, there is considerably less deformation of the metal and considerably less heat generated in cutting. The importance of maintaining, in practice, as large a shear angle as possible is evident.

What part, if any, can a cutting fluid play in providing a large value of shear angle? The interesting fact is this: The size of the shear angle is controlled directly by the friction on the tool face. The lower the friction, the larger the shear angle! If the friction between chip and tool is reduced by application of a cutting fluid, then the heat coming from that rubbing friction is of course reduced too. But, at the same time, that reduction in friction causes the shear angle to rise from a small value to a large value. Consequently, the heat coming from deformation of the metal is also reduced. The two are directly related! In a bearing, when a lubricant is applied, only the heat generated by rubbing friction is reduced. But in metal cutting we get a bonus —free. Every time the rubbing friction on the tool face is reduced, the deformation of the metal and the heat generated thereby are also reduced. In that respect, metal cutting is unique in the field of lubrication.

To illustrate the extent of this control over heat in the metal cutting process, the results of a simple calculation based on this change in shear angle are given in Table I. Assume that, when machining without cutting fluid, the coefficient of friction between chip and tool has a value of one. (This is a normal average value for dry cutting.) Under the conditions given in the table, the heat produced by friction amounts to about 44 Btu per pound of metal taken off; that due to deformation of the metal amounts to about 95 Btu per pound of metal removed. Assume now, that by addition of a cutting fluid, the friction coefficient is reduced by only 10 per cent to 0.9. Then not only is the heat produced by friction reduced by over 8 per cent, but, in addition, the heat due to deformation of the metal is decreased by over 5 per cent, because the shear angle has increased in size. So, very nicely, it turns out that one can control all the sources of heat generation in metal cutting by application of a cutting fluid, provided that cutting fluid is able to reduce rubbing friction between the chip and tool.

TABLE I

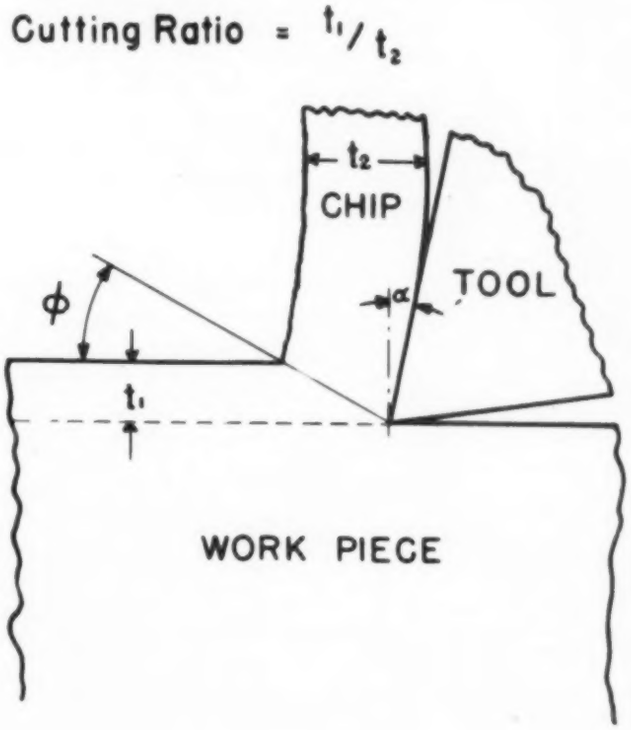
Typical Effect of Reduced Chip Friction on Heat Produced in Machining
Alloy steel: Shear strength = 100,000 psi
Machining constant = 75 degrees
Tool: True rake angle = 15 degrees

Condition	Coefficient of friction	Heat evolved from chip friction, Btu/lb of metal removed	Heat evolved from deformation of metal, Btu/lb of metal removed
Dry	1.0	43.9	95.6
Cutting fluid	0.9	40.3	90.3
Per cent decrease	10	8.2	5.5

Figure 4 — View through microscope reveals details of the two processes which produce heat in machining — deformation of the metal and sliding of chip on tool.

We now need a convenient yardstick to work by, to use in measuring and dealing with the deformation of the metal. Such a yardstick is provided by a quantity known as the "cutting ratio", defined in Figure 5. As already indicated, if the shear angle is low, then the thickness, t_2, of the chip will be much greater than

Figure 5 — Deformation of the metal takes place on the shear plane. The amount of deformation is measured by the cutting ratio.



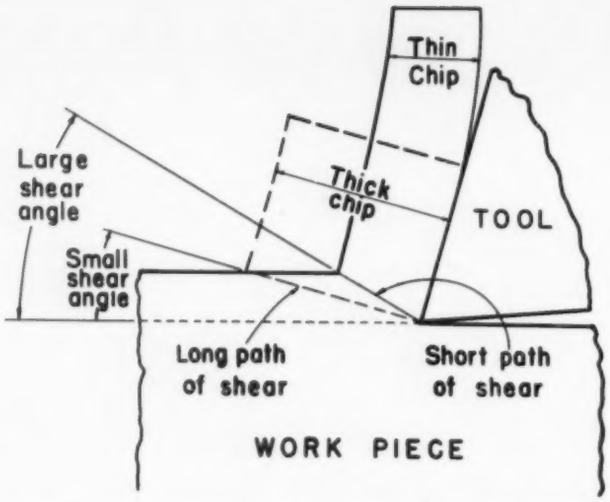


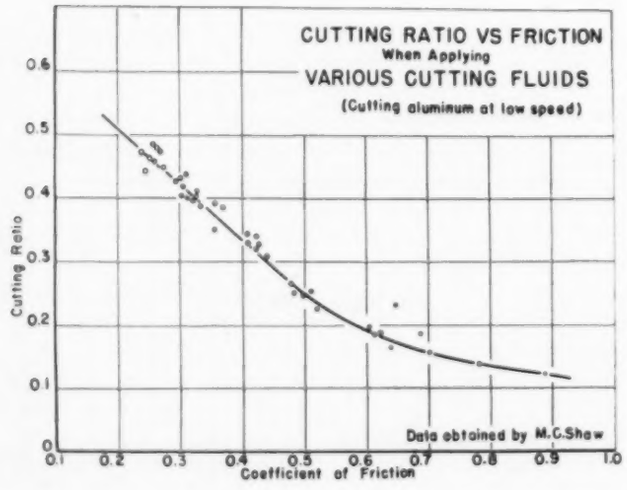
Figure 6 — The amount of deformation of the metal is controlled by the size of the shear angle.

the thickness, t_1, of the layer of metal which the tool is removing. On the other hand, if the shear angle is high, the chip will not be appreciably thicker than the layer of metal being removed. Thus, the ratio of the thickness t_1 to the thickness t_2 (Figure 5) can be used as a measure of the deformation in cutting; that ratio is called, for convenience, the cutting ratio.

As already indicated, the amount of deformation of the metal is influenced by the friction between the chip and tool. Therefore, the cutting ratio is indirectly a measure of the friction between the chip and tool. When friction is decreased, cutting ratio will increase, and vice versa. In Figure 7, this fact is illustrated by actual experimental data; observed values of cutting ratio and coefficient of friction are plotted to illustrate the inverse relationship between the two. It is evident, from this, that the cutting ratio is a convenient yardstick for the measurement of chip friction also. It will be so used in what follows.

Figure 7 also illustrates another very important fact. It shows that cutting fluids can, and do, reduce friction between chip and tool in the metal cutting process. Each experimental point plotted there represents a different cutting fluid. It is evident that some cutting fluids are quite effective in reducing chip friction while some are quite impotent in that respect. The reasons for these differences will become clear as our story progresses.

Figure 7 — Cutting ratio is directly related to the friction between chip and tool; as such it provides a handy yardstick for measuring the friction reducing abilities of cutting fluids.



Meanwhile, let us pause to look at another bonus that is obtained, in metal cutting, when the friction between the chip and tool is reduced by a cutting fluid. Up to now the discussion has centered mainly around the important problem of the control of heat—the improvement of tool life by the lowering of tool temperature, brought about by good cooling and good friction reduction. However, there is another important benefit obtained from the reduction of friction in the metal cutting process. It is associated with another happening that sometimes goes on in the process of metal cutting. Figure 8 is a photograph of a chip, somewhat similar to that shown in Figure 4. However, the present case is a photo-micrograph of a section through a chip. It was obtained by stopping the cut, sectioning the chip, polishing and etching to bring out the structure, then photographing it at high magnification. The difference between the type of chip formation shown in Figure 8 and that shown in Figure 4 is that an additional entity is present. This is known as "the built-up edge." This built-up edge is a mass of stagnant metal on the nose of the tool, and, in Figure 8, can be plainly seen attached to the chip in this position. It plows ahead through the metal and forms the chip, rather than the chip being formed by actual contact with the cut-

Figure 8 — When a built-up edge is present in the process of chip formation, it sheds fragments behind it on the work surface, which cause poor finish.

ting edge and face of the tool. The built-up edge comes into the picture when friction between chip and tool is high, and that is a normal condition in most machining operations carried out at usual cutting speeds. However, the built-up edge is a trouble-maker because it causes the surface finish of the work to be poor. Portions of the lower end of the built-up edge shear away and leave step-like fragments on the surface. Such a fragment can be seen on the work surface in Figure 8, immediately behind the cutting edge. It is these fragments of built-up edge which cause the rough, torn appearance of an ordinary machined surface. Thus, surface finish is poor when a large built-up edge is present. But if the friction on the tool face is reduced, the size of the built-up edge will also be reduced. If friction is reduced far enough, the built-up edge will actually be eliminated. (This is the situation in Figure 4.) Therefore, the lower the friction between the chip and the tool, the better will be the surface finish in machining—another bonus from the friction-reducing action of a cutting fluid.

In Figure 9, this fact is illustrated by actual experimental data. Here cutting ratio is used as a measure of chip friction, since the two are inversely related as already explained. The material machined was aluminum, which is a bad actor as far as surface finish is concerned. It can be seen that as chip friction was reduced (by application of a series of increasingly effective cutting fluids) there was a marked improvement in surface finish. The reason, of course, is that the built-up edge became smaller as the friction was decreased. It can be seen that at high values of cutting ratio (low chip friction) the built-up edge evidently disappeared entirely, so that further reduction in friction did not result in any further improvement in surface finish. Such data illustrate the fact that cutting fluids provide control of surface finish as a result of friction reduction, in addition to providing control of heat.

Let us now come back to the question that is still unanswered: "How does a cutting fluid control chip friction and why are there differences between cutting fluids in this respect?" To do that, we need, once again, to look at the metal cutting process. If we look at such a picture as Figure 4, it at first seems difficult to understand how a cutting fluid can even get in between the chip and tool, to reduce friction. Yet certainly it has to penetrate, if it is going to do any good. However, further thought shows that if a small section of the chip-tool interface were greatly magnified, it would look as shown in Figure 10. It can be seen that there can never be complete contact between chip and tool, since the tool face can never be perfectly smooth. No surface finish that it is possible to produce on the face of a tool can give a perfect plane. There will always be hills and valleys, although minute. Thus as the chip moves up the tool face, it will mainly contact the hill-tops, and never quite fill the valleys. As a result, there will always be a network of capillaries in between the chip and the tool. It is those capillaries which draw in the cutting fluid. Just as a sponge soaks up water because of the network of capillaries in the sponge, so the interface between the chip and the tool soaks up cutting fluid because of the capillaries that exist there. It is by such means that the cutting fluid penetrates the chip-tool interface.

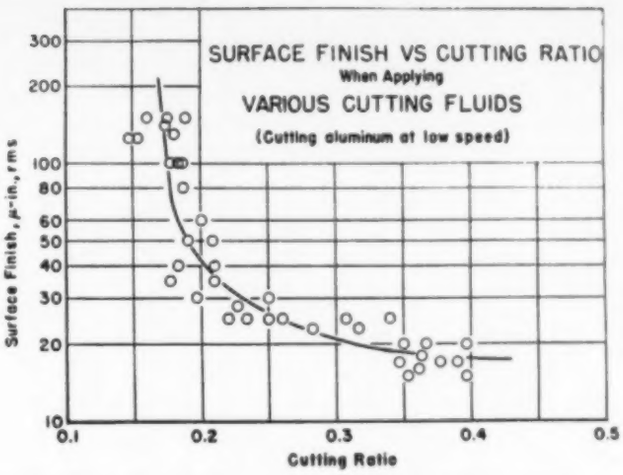
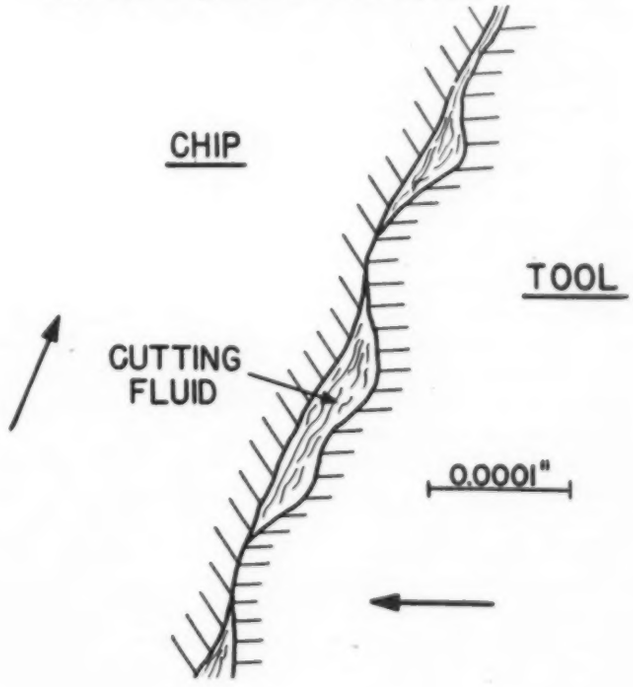


Figure 9 — The greater the friction reducing ability of a cutting fluid as measured by the cutting ratio, the smaller is the built-up edge and so the better the surface finish.

The conditions that the cutting fluid must face when it reaches the chip-tool interface are very severe. First of all, it is known from other types of measurements that the pressures on the points of actual contact between chip and tool run extremely high—several hundred thousand pounds per square inch, in the case of steel. Local flash temperatures at those points also run high, as is known from friction studies made not only in our own laboratories but in others as well. In addition, the geometry of the system offers no possibility for wedge-film formation, such as occurs in a normal bearing. Thus it is impossible to get hydrodynamic action between the chip and tool—to float the two apart on a fluid film of oil the way a bearing floats in a journal. The extremely high pressures, high temperatures, and the poor geometry prevent this. Further-

Figure 10 — Capillaries at the chip-tool interface draw in the cutting fluid; it then reacts chemically with the chip metal to produce a "solid lubricant."



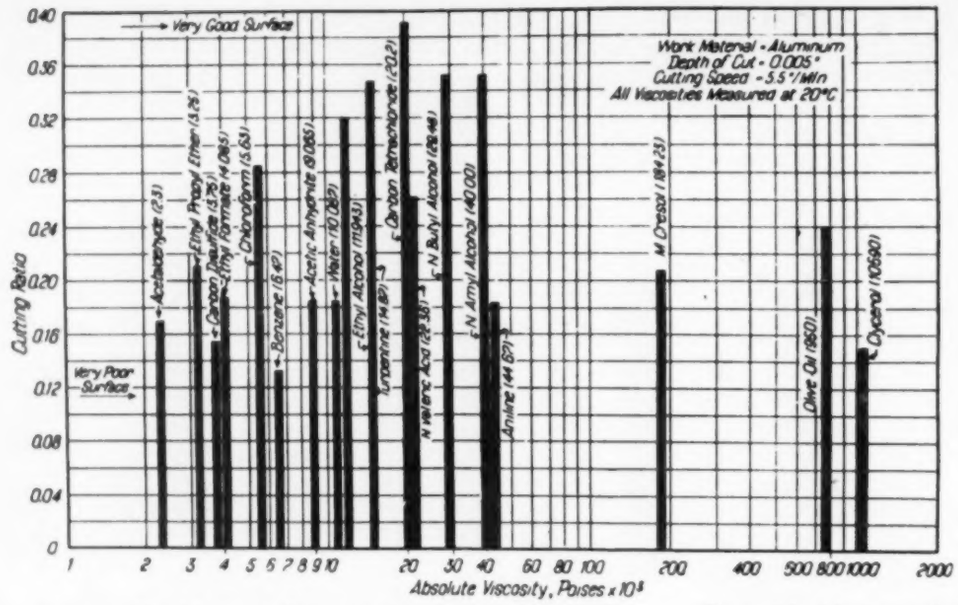


Figure 11 — The fact that the friction-reducing action of a cutting fluid bears no relation to its viscosity indicates that this action is not accomplished by fluid-film lubrication.

more, any liquid, as such, present in the capillaries between chip and tool, will be squeezed out completely from between the contact points because of the very high contact pressures. Thus, there is bound to be metal-to-metal contact between the high points on chip and tool, if only a liquid is present there.

Figure 11 presents actual experimental data illustrating the fact that hydrodynamic or fluid film-lubrication plays no part in the process of friction reduction in metal cutting. It may be seen that the friction-reducing abilities (as measured by the cutting ratio) of the variety of fluids represented there, bear no relation whatever to the viscosities of those fluids. In fact some of the most effective of them have very low viscosities. Consequently, water, oil, or other fluids which remain liquid at the chip-tool interface, cannot provide lubrication or friction reduction between chip and tool. It is necessary to depend, instead, on a different action.

The action by which an effective cutting fluid is able to reduce chip friction might be called "solid-film lubrication". It depends on the formation of a film of solid at the chip-tool interface, which cannot be squeezed from between the contact points, no matter what the pressures are. This solid film is produced by chemical reaction. This reaction is accomplished by chemical additives carried in the water or oil used as the vehicle. At the chip-tool interface there are, as pointed out, very high local pressures and temperatures. In addition, the surface of the chip is freshly produced from the bulk metal and so is clean and "nascent". These conditions are ideal for producing chemical reactions. Chemical compounds which are normally inert toward metals will react readily with them under these conditions. Thus, under the conditions existing at the tool face, additives having the proper chemical properties will react with the chip metal there to form, as reaction products, films of low strength solid materials. These will prevent metal-to-metal contact at the high points and so allow free sliding of chip on tool.

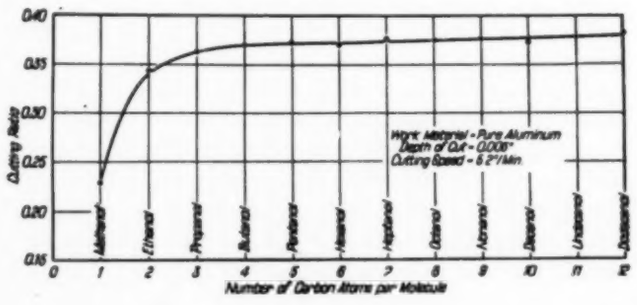
For example, suppose that a cutting fluid contains, as an additive, a chlorine-containing compound of proper chemical reactivity. Suppose that the work material is steel. Then, at the chip-tool interface, the chlorine will react with the steel to produce iron chloride. Iron chloride is a relatively weak solid having a fairly high melting point. As such, it provides an excellent "sandwich-filling" to keep chip and tool apart, thereby reducing chip friction.

Figure 12 presents actual experimental data showing the relation between chemical properties and friction reducing ability. In this case the chemical compounds studied were the "family" of straight-chain alcohols. The chemical properties of these alcohols change in a regular manner with the number of carbon atoms, or chain length, of the molecule. It can be seen that the friction reducing abilities (as measured by the cutting ratio) of the members of the family also change in a regular manner with chain length. The solid film formed at the chip-tool interface in the case of these alcohols is the corresponding metal alcoholate.

Thus, the action of a cutting fluid in reducing friction in the metal cutting process depends on its chemical properties. Cutting fluids must therefore be tailored to contain additives which have proper chemical reactivity and which form proper reaction products at the chip-tool interface. However, their reactivity must not be too great or they will attack the work material. The additives must be unreactive at atmospheric temperature and pressure; they must become reactive at the temperatures and pressures existing at the tool face. The tailoring of effective cutting fluids is therefore a problem requiring advanced knowledge of both the chemistry and physics of the metal cutting process.

The facts presented have shown the importance of

Figure 12 — The friction reducing ability of chemical compounds is directly related to their chemical properties.



both the cooling action and the friction-reducing action of a cutting fluid. It is necessary, however, to understand how the relative importance of each is affected by the machining process itself. Figure 13 presents data giving an insight into this matter. It shows how cutting fluid performance varies with cutting speed. It can be seen that at low cutting speeds, different cutting fluids vary greatly in their ability to reduce chip friction. In other words, at low speeds very considerable benefits can be obtained from chemical action. However, as cutting speed is increased, there is less time available for the fluid to penetrate the chip-tool interface—less time also for it to react—and so friction reducing ability falls off with increasing speed. At speeds of about 100 fpm, the chemical action is quite a bit less effective than at low speeds. At speeds of about 400 fpm, such as are used with sintered carbide tools, chemical action practically goes out of the picture. Only water maintains a high value of cutting ratio and this is due, not to its chemical action, but to its good cooling ability, which affects the plastic properties of the metal. Thus at high cutting speeds good cooling ability is of prime importance, while at low cutting speeds good friction reducing ability is required. An all-round cutting fluid must therefore combine both those properties to the highest possible degree.

In conclusion it may be said that, as a result of such basic scientific research as has been described here, many of the fundamentals of the action of cutting fluids in machining are now clear. However, it is evident that there is much which continuing research of this type can still reveal. Thus, as such research continues, the frontiers of knowledge must continue to roll back to provide increasing benefits to all.

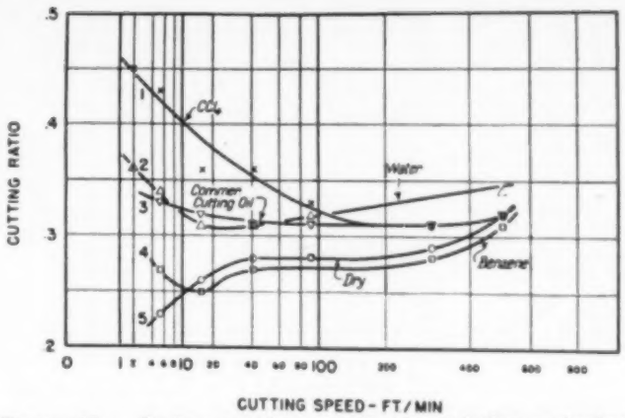


Figure 13 — At low cutting speeds the friction reducing ability of a cutting fluid plays an important role; at high speeds cooling ability is most important. An all-round cutting fluid must combine both to a high degree.

DISCUSSION

PRESENTED BY

E. S. REYNOLDS, Professional Engineer, Socony-Vacuum Oil Co., New York, N. Y.

M. EUGENE MERCHANT, Senior Research Physicist, The Cincinnati Milling Machine Co., Cincinnati, Ohio

V. C. ORANGE, Maintenance Service Superintendent, Atlas Steels, Ltd., Welland, Canada

M. D. STONE, Manager, Development Department, United Engineering & Foundry Co., Pittsburgh, Pa.

F. P. DAHLSTROM, Consulting Engineer, New Haven, Conn.

E. S. Reynolds: In one of the charts, Dr. Merchant showed a ratio of oil to water, and the cooling effect resulting. I would be interested in knowing what the viscosity of those oils were; and if the emulsifier had a cooling effect? I wonder if you have done anything on that.

M. Eugene Merchant: The viscosity of the oil used in these tests, before dilution with water, was that of the usual soluble oil, or roughly 500 centistokes at 100 F. The viscosity of the chemical emulsion concentrate used in these tests, before dilution with water, was approximately 2 centistokes at 100 F. It was not possible from these tests to trace any direct cooling action to the emulsifiers alone. Rather, the actual oil content of the emulsion was found to be the important factor.

E. S. Reynolds: In your curve, showing the chip moving over the face of the tool, did I understand you to say that you believe the formation of ferrous chlorides, and other substances, takes place on the chip and not on the tool; or do you think it takes place on both?

M. Eugene Merchant: It can take place on both. The most desirable condition, of course, would be to have the cutting fluid react only with the chip metal and not at all with the tool. As it reacts with the tool, one gets wear of the tool—chemical erosion of the tool—and this can contribute to tool failure. In the ordinary case of machining, of course, the metal being machined is, almost without exception, much more reactive, chemically, than the tool. High-speed steel and sintered carbides are, in general, chemically inert as compared to steels and other readily machinable metals. However, if the additive in the cutting fluid is too active, there will be excessive reaction with the tool and rapid chemical erosion. In such a case one may get increased tool wear by application of the cutting fluid. Thus it depends on the reactivity of the cutting fluid additives as to how much reaction with the tool takes place.

V. C. Orange: I understand that 25 per cent of this friction is heat-creating friction on the face of the tool. Now then, would it be possible, by mechanical means —I am not talking about lubricants, I am talking about mechanical means—to eliminate part of this 25 per cent by relieving the face of the tool above its contact with the metal slightly, in order that the tool will not drag so far up the face before it makes the other trip? I have in mind that friction of the tool face is very considerable. The point is, in your experiments, did you find that the chip starts its curve right from the point of contact—call it shearing of the metal—of the chip, or does it continue up the face of the tool? If it continues up the face of the tool, would it or would it not be possible to reduce the chip pressure above cutting area of tool—a slight amount, maybe a sixty-fourth of an inch or a thirty-second of an inch

so that the tool is free of the face of the cutting edge? I appreciate the fact that, if very much relief is given, you are going to have a fracture of your tool because of the tremendous pressure exerted against the cutting edge. But, if you could reduce the two-thirds down on that face, just slightly, would it or would it not, mechanically, help to reduce that 25 per cent?

M. Eugene Merchant: When an attempt is made to remove a portion of the tool face from contact with the chip, just above the cutting edge by relieving it (i. e. by grinding a "secondary rake angle"), it is found that the chip follows this new tool contour. As a result the area of contact with the tool face is little changed, and, in the general case, little if any benefit is obtained.

M. D. Stone: At the high speeds, I think your curves show that water is the best lubricant—probably due to its cooling effect. How does the cooling affect the cutting ratio as cooling effect? From what you said previously, I gathered it was the friction that affected the cooling, not the cooling effect.

M. Eugene Merchant: In giving a presentation like this, one touches on the high points of metal cutting theory, omitting certain details, and that involves one of them. While the cutting ratio is influenced mainly by the friction between the chip and tool, that, actually, is not the only factor influencing it. The cutting ratio is also influenced by the plastic properties of the metal being cut. When dealing with a given metal, these properties normally remain relatively constant. However, in the case where water was applied to the cutting operation and the cutting speed was high, the cooling action was so severe as actually to modify the plastic properties of the metal. Thus, the fact that the cutting ratio was high in this case was not due to friction reduction but was due, instead, to the improved plastic properties of the metal, brought about by the quenching action of the water.

M. D. Stone: At the high speeds I gather there is not much difference between the worst and the best lubricant, i. e. dry cutting and water. Now, going to the other end of the same picture (for low speeds), you show a great difference between the best lubricant, which I noticed was carbon tetrachloride, and the worst. How do you reconcile that picture with the outstanding case of roll turning where the difference between lubricants tried is so inconsiderable that every one practically turns dry. It is not worth cooling, yet there is an enormous improvement indicated.

M. Eugene Merchant: What cutting speed would that be?

M. D. Stone: Ten, twenty, perhaps thirty feet per minute.

M. Eugene Merchant: If no benefit is observed at these low speeds, it is most surprising because, usually the place where a cutting fluid can show best performance, as far as friction reduction is concerned, is in the low speed range.

M. D. Stone: The point of importance there, is I think that the temperature on a cutting tool is so low, by virtue of being very wide, that these temperature factors do not considerably affect the life of the tool.

F. P. Dahlstrom: If I recall correctly, Dr. Merchant showed that viscosity is relatively unimportant when judging the value of an oil as an aid to machining.

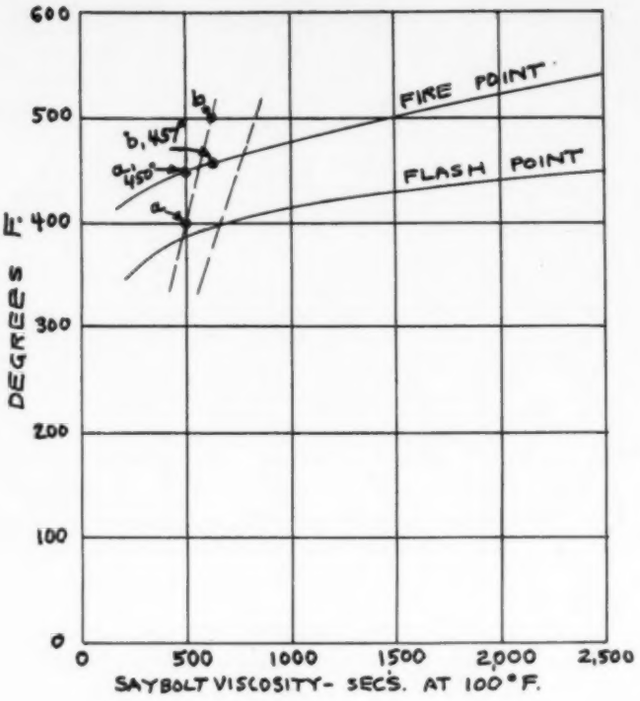


Figure 14 — Relation of flash and fire point to viscosity.

This reminds me of the period when hypoid gears were first used in the final drive of automobiles. It was soon found that straight mineral compounds were unsuitable for the service.

Many types of lubricant testers were designed to evaluate various oils and compounds—and there seemed to be a lack of consistent results from the testing machines. When a lubricant breaks down we have as a contributing cause, excessively high temperatures due to sliding under great local pressure.

In order to show that viscosity is perhaps a negligible factor in judging an oil for extreme pressure conditions, Figure 14 has been prepared which shows the relation between viscosity and average flash and fire points. If the viscosity is increased, say from 500 to 650 seconds (or 25 per cent) the fire point does not increase 25 per cent, or from point "a" to point "b"—but increases only from 450 F (point a_1) to 457 F (point b_1). If it is logical to use a percentage with zero degrees F as a base, then the increase in fire point is only 1½ per cent.

The local temperatures which are generated are much higher than any of the temperatures indicated—which again might prove that viscosity is unimportant.

If there are any "contaminating" products in the oil it might be correct to assume that these products are more readily released by a "lighter" oil than by a more viscous oil.

M. Eugene Merchant: The fact that the viscosity of a cutting oil, as such, has little effect on its performance is well borne out both by laboratory tests and by practice. The chemical properties of the additives carried by the oil (serving as a vehicle) are the main factors controlling the effectiveness of a cutting oil.

B. C. BLAKE
BIRMINGHAM DISTRICT SECTION

WILBUR G. SMITH
BUFFALO DISTRICT SECTION

R. W. HOLMAN
CHICAGO DISTRICT SECTION

AISE DISTRICT CHAIRMEN 1950 - 1951

B. C. BLAKE was born in Lexington, Ky. He attended Washington & Lee University and then transferred to Alabama Polytechnic Institute where he received his degree in civil engineering. He began work with Connors Steel Co. in May, 1929, as a detailer in the structural engineering department. He later advanced through the following jobs: assistant fabricating shop foreman, mill foreman, plant engineer, chief engineer, assistant works manager and works manager. In November 1950 he was also made vice president.

WILBUR G. SMITH entered Rensselaer Polytechnic Institute in 1930, and received a B.S.M.E. in 1934. That same year he started with the Bethlehem Steel Co., Lackawanna, N. Y., as millwright in the bar mills. He was then advanced to a turn foreman in the 54 in. blooming mill and 48-in. structural mills. After a short period of time, he became assistant general foreman in the billet preparation department. The next move was to assistant superintendent of the 54 and 48-in. mills. In August of 1948, he became superintendent of the 54 and 44-in. blooming mills, 32-in. rail mill, and the splice bar and tie plate shop. His present position is assistant superintendent of the strip mill, which change took place August 1950.

R. W. HOLMAN was born in Chicago, Ill. July 24, 1911 and moved with his family to Gary, Ind. one year later. After completing high school in Gary, he worked two years as a finish catcher in the Gary Tin hot mills of the American Sheet and Tin Plate Co. prior to entering Purdue University. He was graduated from Purdue in 1935 with a BS degree in Electrical Engineering. After graduation he started as electrician's helper at Gary Sheet and Tin Mill of Carnegie-Illinois Steel Corp. In early 1938 he advanced to power foreman, and during 1940 was appointed assistant to superintendent electrical maintenance. During 1946 he was appointed general supervisor electrical engineer and in May 1950 advanced to his present position of assistant works chief engineer, Carnegie-Illinois Steel Corp. Gary Sheet and Tin Mill, Gary, Ind.

LEONARD LARSON was employed as draftsman at Jones & Laughlin Steel Corp. and Carnegie Steel Co. in Pittsburgh, Pa. from 1913 to 1917, while attending night school at Carnegie Tech. He moved to Massilon in 1917 as draftsman for Central Steel Co., was appointed chief draftsman in 1918 and assistant chief engineer about 1923. He was appointed assistant chief engineer for Central Alloy Steel Corp., in 1926 in merger between Central Steel Co. and United Alloy Steel Corp., and was appointed chief engineer in 1929. He served in this capacity for Central Alloy Steel Corp., and Republic Steel Corp., after merger in 1930, until 1939, when he was transferred to Cleveland District as district chief engineer. During period from 1933 to 1936, he spent about one year on special open hearth work for the corporation, and about two years in the operating department as divisional superintendent at the Massilon Steel plant.

W. J. REILLY was born in Youngstown, Ohio, where he attended grade school and high school. He graduated from University of Michigan in chemical and metallurgical engineering, and started work at Youngstown Sheet and Tube in the metallurgical department in 1926. He served in various capacities in the metallurgical department, fuel department, bessemer and open hearth departments. He was appointed superintendent of the open hearth in 1943. He left Youngstown Sheet and Tube Co. to go to the Ford Motor Co. in April 1946 as assistant superintendent of steel operations. He was appointed manager of steel mills in 1949.

ROBERT W. COUCH was born at Independence, Va., and later moved to Roanoke where he graduated from Jefferson High School. In 1928 he received a B.S. degree in Electrical Engineering from Virginia Polytechnic Institute. He entered the loop training course of the Bethlehem Steel Co. at Bethlehem, Pa. in June of the same year. From 1928 to 1936 he served successively as draftsman, repairman, motor inspector, wireman, sub-station operator and experimental engineer. In 1936 he was made assistant general maintenance foreman of the structural mills in Saucon Division. In 1939 he became general electrical foreman of Saucon Division, and in 1941 assistant superintendent maintenance. In 1948 he was appointed to his present position of superintendent of electrical and mechanical maintenance in the Saucon Division of the Bethlehem plant.

A. G. ERICSON was graduated from School of Mines, Filipstad, Sweden in 1916. He arrived in the United States in 1920. He started work with the Carnegie Steel Co. at Homestead steel works in 1924 and successively progressed as mechanical draftsman, engineer, assistant to the chief engineer, assistant chief engineer, and in 1938 was appointed chief engineer for the Homestead district works of Carnegie-Illinois Steel Corp.

LEONARD LARSON
CLEVELAND DISTRICT SECTION

W. J. REILLY
DETROIT DISTRICT SECTION

ROBERT W. COUCH
PHILADELPHIA DISTRICT SECTION

A. G. ERICSON
PITTSBURGH DISTRICT SECTION

SLIDING CONTACTS FOR TRANSFER OF ELECTRICAL ENERGY FOR INDUSTRIAL SYSTEMS

By H. YALE MAGEOCH
Chief Engineer
Electric Service Manufacturing Co.
Philadelphia, Pa.

. . . . many collector system designs have been developed for steel mill practice . . . .

▲ THE subject of providing third rail systems or sliding electrical contacts for the operation of industrial equipment is often left open until the machine to be operated has been specified or is available for installation. In many cases space has not been provided and suitable mounting locations have not been selected for installation of the necessary elements. It is thought that by discussing the various systems available along with associated equipment, some facts might possibly be provided that would be of assistance in the selection of electrical contact material for the operation of industrial machinery.

COLLECTOR SYSTEMS

Classified with Respect to Conductor Used

It is possible to break down the available systems into:

1. Wire systems (Figure 1).
   a. Pick up systems, which are those employing wire loosely supported by insulating members (Figure 1A).
   b. Systems employing fixed supports or trolley ears (Figure 1B).
2. Rigid conductor systems (Figure 2).
   a. Steel rails such as those manufactured under the ASCE specifications (Figure 2A).
   b. Structural shapes such as steel angle where one of the outer faces of the angle is employed as a contact surface (Figure 2B).
   c. Steel angle used in inverted position normally known as the inverted "V" system where the contact member makes contact on the inside of the angle in such fashion that two contact surfaces are employed for transferring the current (Figure 2C).
   d. Steel "T" bar (Figure 2D).

   (Non-ferrous conductors are also used. In this group can be included copper, brass, or aluminum angles or other standard bus bar shapes. A second group in the non-ferrous class is covered by extruded aluminum conductors of special shapes some of which have been used in the Pittsburgh area.)
3. Special systems:
   a. The plow.
   b. The fixed shoe moveable rail.
   c. The rail with trolley.

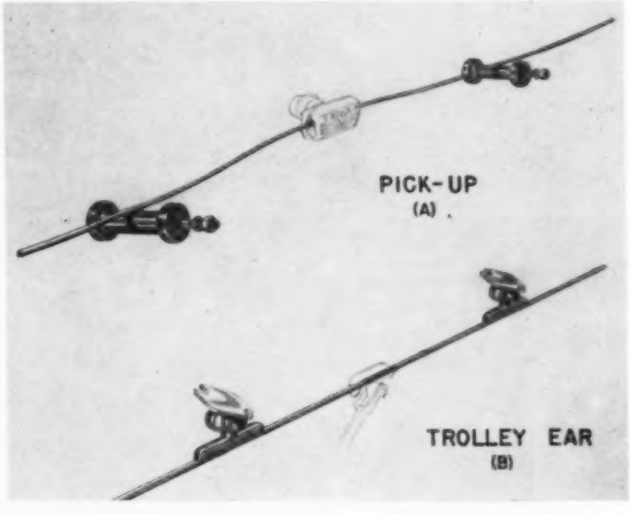
The construction of these systems will be discussed later.

COLLECTORS

For the various systems already mentioned collectors of different types must be employed in order to meet each particular condition. Collectors available are generally those using sliding shoes or wheels. Sliding shoes are most often preferable where heavy currents are to be conducted and where heavy surges are encountered. Wheels are suggested for applications where lighter currents are encountered, and where adverse conditions may cause excessive shoe wear due to the sliding action between the conductor and the shoe. These wheels roll, and providing there is no burning present on the conductor surface, wear is reduced.

The various forms of collectors available are those

Figure 1 — Two types of wire collector systems are illustrated in this sketch.



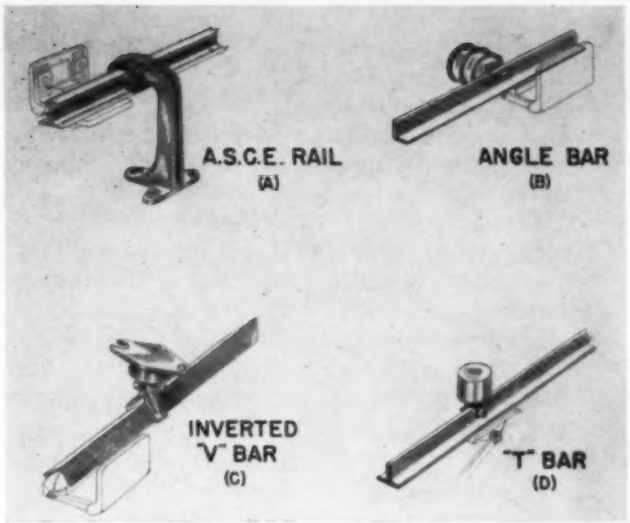


Figure 2 — Four types of rigid conductor systems are illustrated in this diagram.

of the pickup type, the pivoted arm type, and the pantagraph type (See Figure 3). Both the pickup and the pivoted arm types can employ either a sliding shoe or a wheel. Most frequently used is the pivoted arm type which has a spring loaded arm connecting the shoe or wheel with the base member. The pantagraph collector may have either a shoe or a wheel. All collectors except the pickup type can either be gravity or spring loaded, although, generally, gravity loaded collectors are large and heavy and require considerable space. Spring loaded collectors usually require less space and are more compact in design.

COLLECTOR SHOE MATERIAL

Typical materials used for the contact member of the collector are cast iron, bronze, or graphite. Cast iron contact members have a low co-efficient of friction and have good wearing qualities. They are usually composed of gray iron, and in some cases a chilled contact surface is employed. In the event that unusual wearing qualities are required, special contact members of high chrome iron can be secured, however, a contact member of high chrome iron is difficult to machine and is, therefore, costly. Bronze contact members have the advantage that they do not corrode under normal conditions, consequently they may be permitted to stand idle for periods of time without a marked detrimental effect. Bronze contact shoes will carry currents larger than those of cast iron by as much as 25 to 50 per cent.

The use of graphite as a contact member is now being given considerable attention in the industrial field. As a rule, graphite shoes can not be installed for operation on old contact surfaces, where the contact surface is rough or where large breaks in the rail would result in high impact on the contact member.

Graphite unsupported is not mechanically strong and will deteriorate rapidly if rough surfaces or projections on the rail interfere with the graphite. This comment refers particularly to graphite used as a sliding shoe. Where graphite wheels are operated on rough contact surfaces such as bent and pitted wire, or where trolley ears are not of proper design, there may be resulting damage to the graphite wheel. Graphite contact members will give the best performance when installed on new systems.

A satisfactory type installation employing graphite collectors can be found in the pickup system. The wire, when new, used on the pickup system is free of obstructions or roughness and will, therefore, take on a polish and a slight coating of graphite. This will result in extremely long life and trouble free operation of the collector system. Graphite due to its inherent high re-

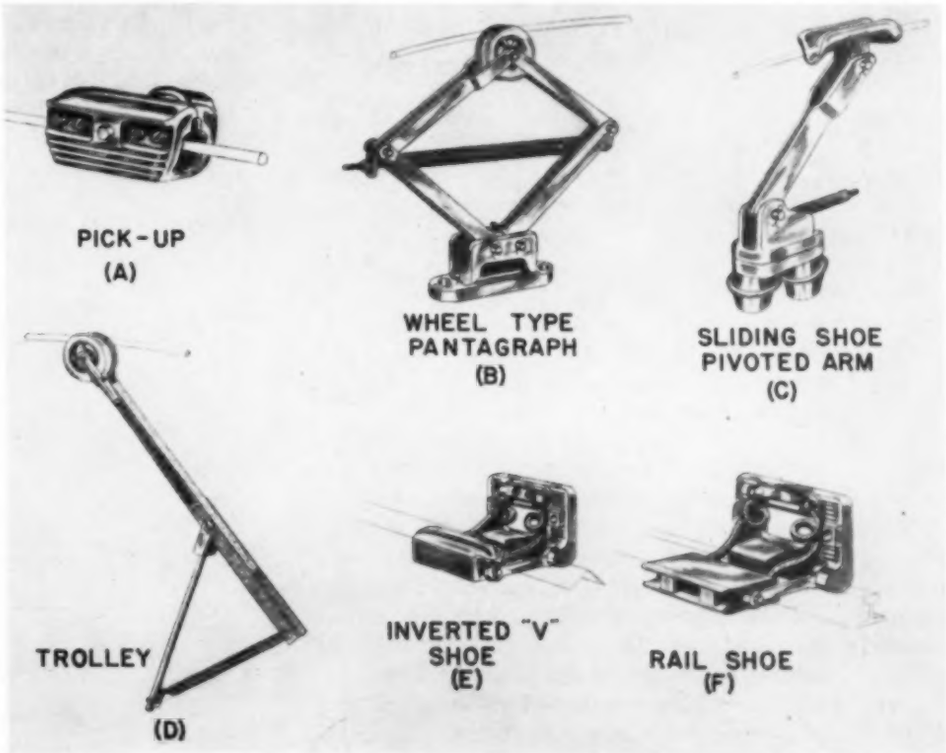


Figure 3 — Many different types of collectors have been developed for collector systems.

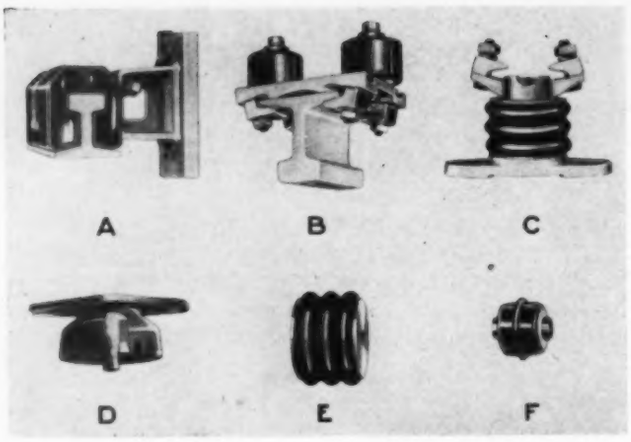


Figure 4 — The best insulators are of the wet process type.

sistance can easily cause damage to the collector system if, while standing, heavy currents are carried through the graphite. Damage will be caused particularly to wire systems due to the very low thermal capacity of the wire.

INSULATORS

Insulators used for supporting conductors and collectors are as a rule either porcelain or composition, although in some instances impregnated wood blocks have been used.

In the porcelain insulator family the wet process porcelain is far superior to dry process and should be used wherever possible. Wet process porcelain will not absorb moisture and has high mechanical strength. Dry process porcelain, if used, should have all exposed surfaces glazed in order to eliminate the possibility of moisture absorption.

Composition insulators are usually of moulded phenolics, cold moulded materials, or machined asbestos products.

Moulded phenolics have the advantage of high mechanical shock resistance coupled with reasonably high mechanical strength and good dielectric properties. When proper materials are selected, moisture absorption is low. However, resistance to tracking does not compare with porcelain.

Cold moulded materials have high heat resistance, low mechanical strength and usually, unless impregnated, have a high rate of water absorption. Cold moulded materials are resistant to tracking and their dielectric properties are fair.

Ebony asbestos is usually machined from blocks, and falls in a category similar to the cold moulded materials. It, however, is relatively expensive.

Wood at the present time, is not being used for supporting new conductor systems. However, it is still used in many cases for the construction of gravity loaded collectors, and in some instances, industrial pivoted arm collectors of the trolley pole type. Wood strain insulators can still be found in use by transportation companies, but have been replaced in industrial applications by porcelain or moulded phenolic insulators employing a combination of phenolic material and mica.

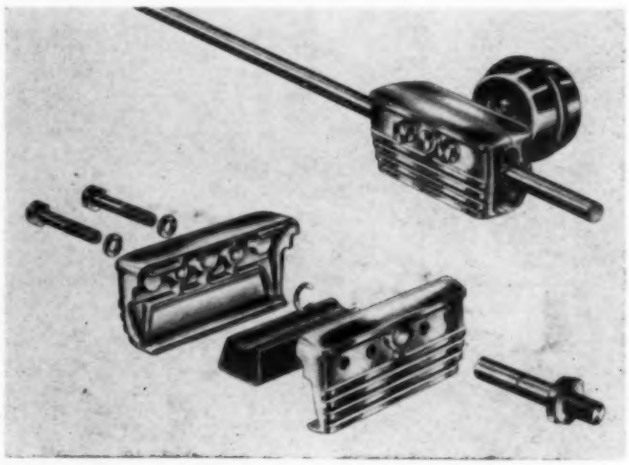
Figure 4 shows typical insulators now in use:

a. Split porcelain insulator for ASCE rail for under-running operation with the base of the rail used as the contact surface.
b. Porcelain covered composition strain insulators with hardware for ASCE rail for under-running operation with the ball of the rail used as the contact surface.
c. Porcelain or composition insulator with hardware for ASCE rail for over-running operation.
d. Metal clad composition insulator for use with trolley ears for supporting grooved trolley wire.
e. Porcelain or composition tapped insulator for use with suitable hardware for the support of structural shapes, ASCE rails, or collectors.
f. Composition insulator with mica insulated tapped metal ends for use with suitable hardware for the support of structural shapes, ASCE rail in under-running position, or collectors.

GENERAL COMMENTS ON SELECTION OF MATERIAL

To make a few general comments for the selection and installation of sliding conductor systems, it can be said that the wire system of the pickup type for short runs where low currents are employed will be found to be highly satisfactory and relatively cheap to install. Maintenance should be low. In the case of the pickup system, it would be well worth while to consider the use of graphite insert collectors (Figure 5) where currents are between 35 and 65 amperes. Pickup collectors are available with removable graphite inserts of various grades. Replacement of the inserts is simple and the space required by the complete collector is extremely small. The pickup system is generally used on a short system probably in the neighborhood of 150 ft. For longer systems the ear supported wire can be considered. In this case, collectors of the shoe or wheel type having a pivoted arm, would probably be first choice. One advantage of the wire system, is that a high degree of misalignment can be allowed without insulator breakage or trouble due to dewirement. The pivoted arm type of collector has a reasonable range

Figure 5 — This pickup collector has a removable type insert.



of motion both in the horizontal and vertical planes, and can therefore be depended on to compensate for some misalignment.

Wire systems can bridge expansion joints without the use of a special expansion joint installation. Generally speaking, the wire system, if it applies, is the cheapest type of system that can be installed.

In selecting wire to be used as a contact member, round copper wire is suggested for pickup systems, and grooved wire for ear supported systems. Figure eight wire should be avoided.

Where heavier currents are encountered it is necessary to use heavier conductors in order to provide additional cross section to increase electrical conductivity and to provide additional thermal capacity. Large sections have increased contact areas for mating with the collector members. At the present time collectors are available in which shoes can be used for currents between 50 and 3000 amperes. Two shoes per conductor should be applied for the 3000 ampere installation. Steel rails of the ASCE type supported by suitable porcelain insulators in under-running arrangement provide one of the best systems for heavy currents. This system can be equipped with guard boards if safety is essential, and brackets are usually of rugged construction thus permitting "cat walks" to be installed over the brackets or special guard boards may be employed if dirt, coal, or scrap is to be piled close to the conductor system. This system is usually installed adjacent to the running rail by extending one or two of the ties at the point where the insulator supporting bracket is to be mounted. Care should be exercised in making this type application to be sure that the foundation for the bracket at this point is solid, for settling of the road bed over a period of time might otherwise shift the bracket, causing insulator breakage and misalignment of the conductor. Installations of this type can be employed for currents up to 1500 amperes, and in some cases where supplementary boosters are used, currents as high as 3,000 amperes can be collected.

Steel sections selected from standard structural shapes provide a wide range of application for conductors in current collecting systems. Steel angles supported from the side by porcelain insulators with tapped inserts, are often used in place of light ASCE rails. This type system should be installed with caution, in order to be sure that difficulty will not be encountered due to contraction and expansion. The mounting holes placed in the leg of the angle adjacent to the insulator should be elongated, and provision should be made to have the bolts holding the angle installed so that they will not tightly clamp the angle. Spacing collars or fittings should be used so that when the nut is pulled up tightly, the conductor member will be free to slide between the conductor retaining members, usually a $\frac{1}{16}$-in. clearance allowance for free movement of the conductor is not too great.

Steel angle used in under-running relation has all the advantages of ASCE rails and generally has higher current carrying capacity for the same weight per yard. In general calculations, a ten to one ratio of steel to copper may be used for ASCE rail, and approximately $6\frac{1}{2}$ to 1 ratio for steel angle based on the use of direct current. It is understood, of course, that material will vary from time to time. However, as a general rule the figure just quoted is reasonably close for warehouse stock. Steel angle used in an inverted "V" system offers one of the best conductor systems available. This system provides a large contact area for the collector members, and at the same time, due to the under-running characteristics, the contact surface is protected from dirt, ice, snow, and moisture. The lower edges of the inverted "V" serve as a drip edge, thus causing moisture to drop off at the edge rather than migrate across the contact surface. Inverted "V" systems are in most cases held by clamps that permit the free movement of the conductor without need for placing holes in the conductor for its support. Splice plates, if employed, must be installed by using flat head screws, and bonding is usually accomplished by welding.

Non-ferrous conductors of shapes similar to structural members are installed by using the same supporting material as employed for structural members. The advantages of non-ferrous conductors such as copper, brass, and aluminum lie in high conductivity along with resistance to corrosion. Systems that stand idle for periods of time will have less trouble starting where non-ferrous conductors are used. One of the principle advantages of non-ferrous conductors is found where alternating currents are employed, for here the damaging effects of inductance and skin effect are reduced by the non-ferrous conductors. It can also be said that another advantage exists in the fact that non-ferrous conductors for a given current can be smaller in size than the ferrous conductors.

ASCE rail and structural shapes, exclusive of the inverted "V" system, can be installed for either under-running or over-running operation. Where possible, under-running operation should be used as the contact surface does not readily collect dirt, snow, or ice. If the contact rail is installed, overhead ASCE rail arranged for over-running operation supported by insulators in compression afford security against dropping of the conductor should the insulators become damaged accidentally.

Insulators should be selected based on their application. For outside use, where possible, porcelain should be used. For inside purposes porcelain or composition could be used, with a preference for porcelain.

If vibration or impact loading is a factor, composition insulators may be considered.

If the insulators are subjected to sustained elevated temperatures (over 225 F), or high thermal shock, cold moulded insulators or machined asbestos insulators will be of assistance.

SPECIAL CONDUCTOR SYSTEMS

Special systems previously mentioned are those not commonly employed; however, some of these systems meet difficult or unusual conditions. Among these systems is the plow system (Figure 6) which is installed below the surface of the ground with the conductors carried in a trough. The contact shoes in this case are carried on an arm extending through a slot in the top of the trough, thus providing a system where no portion of the conductor is exposed, which offers a high

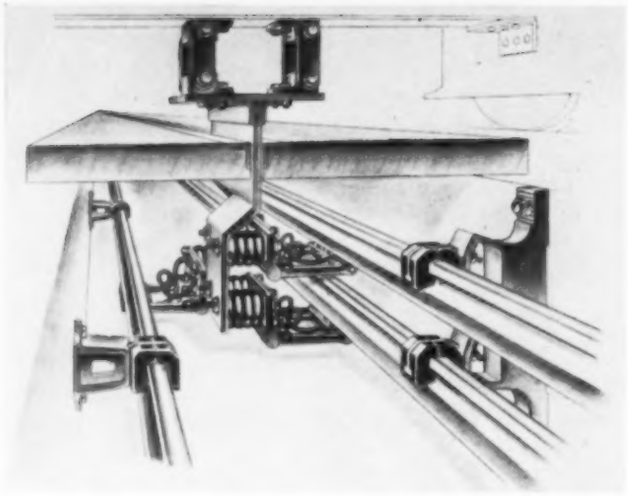


Figure 6 — Plow system type of conductor is installed below the surface of the ground.

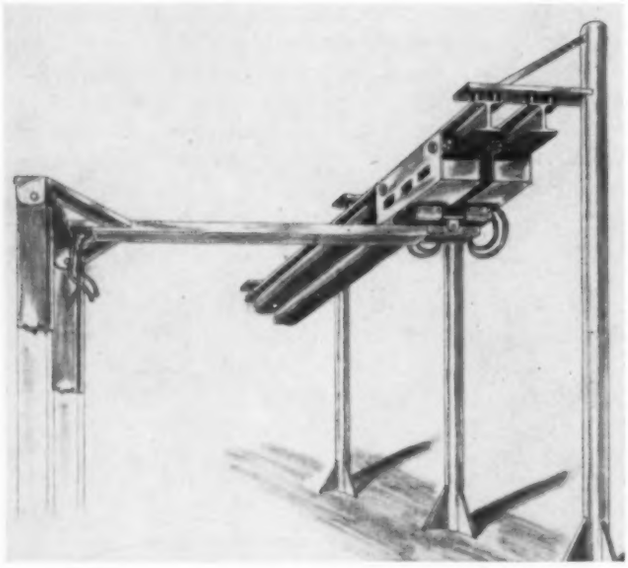
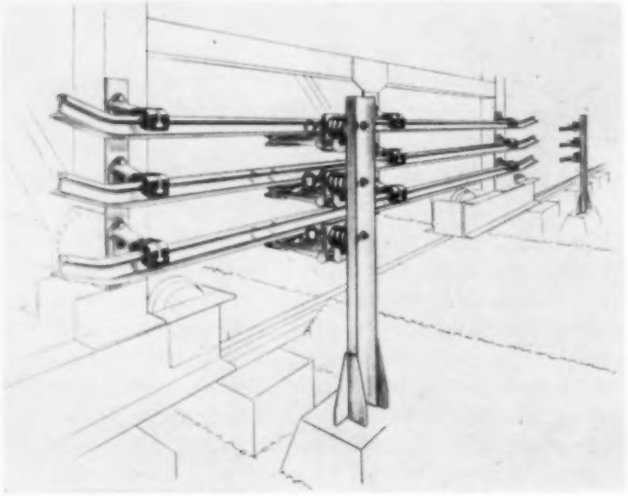


Figure 7 — The sketch shows a fixed shoe and movable rail type system. It is often called the post type design.

Figure 8 — Shown in this drawing is the trolley system design.



degree of safety and avoids all projections above the surface of the ground. This allows the free movement of trucks and workers.

Another type of system falling in the same category is the fixed shoe and movable rail system (Figure 7). This involves the use of a series of posts upon which collector shoes are mounted where the posts are distributed at fixed points along the runway of the crane. At some point on the moving equipment, sections of rail are mounted in such fashion that they will contact the shoes on the posts guaranteeing that the rail would not be out of contact with the shoes at any time. This system eliminates the fence effect set up by the conventional third rail system, and permits trucking and movement of workers over the area without interference.

If desired, safety can be provided for by using section switches to disconnect posts not in operation. In the case of an installation made during the war, automatic control is employed where shoes are energized as required from a control station. Hence cars can be moved at the will of the operator. While it has not been tested, it is felt that a system of this type might provide means for operating under adverse weather conditions, since it would be possible to heat the small mass that makes up the shoes in order to keep the shoes above the freezing point. This is not practical with long sections of rail.

A third system, where wide variation exists between conductor and the point on which the collector is located, is a trolley system (Figure 8) whereby a trolley carrying the necessary contact shoes rides on the conductor, and a transfer arm, designed to permit sliding engagement with the trolley, permits a wide range of motion between the centerline of the conductor and the point on which the transfer arm is mounted. A system of this type is now in operation on mattress sinking barges produced for the government.

LOCATION OF FEEDER TAP

When installing collector systems the location of the feeder tap is of importance. Where it is possible to tap at the center of the system, the voltage drop throughout the system (not including the feeder) will be reduced to one-half. If it is necessary to locate the feeder tap on the end of the system, and heavy currents are carried either intermittently or continuously, it may be necessary to employ boosters.

USE OF BOOSTERS

The application of a booster should be given considerable thought. If the system is a d-c system, the booster can be located on the side of the steel conductor. This should preferably be done by welding solderless connectors at intervals along the conductor at the rate of one or more per rail section. If the system is a-c, the installation of the booster adjacent to the steel rail will contribute little to improve the regulation. This is true because the magnetic flux generated by the steel conductor will encompass the copper conductor and thus reduce its effectiveness. In order to

take advantage of copper boosters on a-c systems, it is advisable to install them approximately 20 in. away from the steel conductor, and in the case of a single or polyphase system, all conductors should be grouped as closely together as possible. This will reduce inductance and will greatly improve the characteristics of the circuit.

USE OF HIGH VOLTAGE

Where large amounts of power are to be transferred through moving conductors, it is advisable to employ the highest voltage possible, since the cost of installation will not change in proportion to the increase in voltage. Insulators generally employed for 220 volt systems can often be used on systems where the voltage may be as high as 2400 volts a-c. The use of high voltage will call for special safety measures, or for locating the equipment far out of reach of workers (see Figure 9).

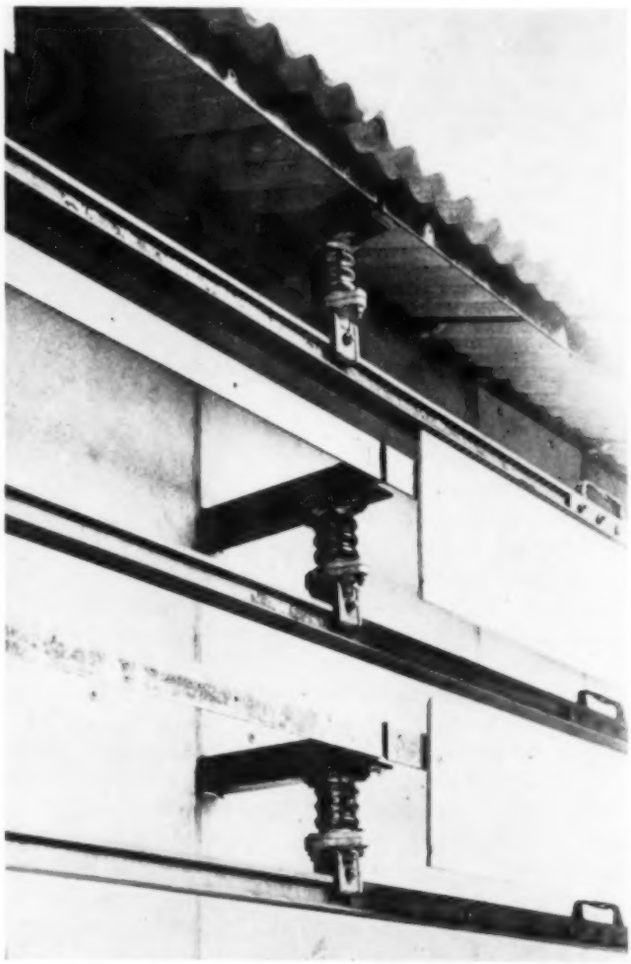


Figure 9 — Where high voltage is present, special safety precautions must be taken to locate the collectors out of reach of the workers.

USE OF MULTIPLE SHOES

For collector systems, where possible, it is generally better to use two or more shoes per conductor rather than to employ one single large shoe. The use of multiple shoes is especially advantageous where lifting magnets are employed, since there is a greater opportunity of guaranteeing a continuous supply of current through the multiple shoes during adverse conditions. Multiple shoe operation has the advantage that a single shoe failure will not cause machine shut down. It also permits the scheduling of maintenance work rather than having repairs made on an emergency basis, for worn shoes can be detected and replaced at the convenience of the maintenance department, since the remaining shoe will keep the equipment in operation if the period of time is not too long.

SOME STEEL MILL TROUBLES

Steel mills experience various mechanical and electrical troubles; a few of these troubles are covered by the following:

Insulator breakage—Many installations employ the under-running system using ASCE rail with split porcelain insulators. Some are old, where settling of the road bed has resulted in serious misalignment, thus causing the supporting brackets to shift and throw a heavy load on the split porcelain insulators. This condition is extremely hard to remedy. However, it might be pointed out that the design of the split porcelain insulator and associated hook bolt is such that the hook bolt should not be drawn up tightly as a clamp, but should be drawn up to a point where the insulators and rail hang in snug engagement. If the hook bolt is drawn up too tightly, it may mean that slight shifting of the bracket will cause chipping and breaking of the insulators. Of course, a point will be reached at which no adjustment of the hook bolt will save the insulator from breakage.

Trouble may be found where provision for contraction and expansion is not taken into consideration, or where hardware becomes locked to the conductor. To avoid this condition all conductor holding methods that are used should be studied to be sure that a free sliding fit is provided. Where conductor members are supported by bolts through drilled holes, these holes should be elongated, and there should be a loose assembly between the conductor and the support.

If porcelain insulators are constant offenders, and all other conditions are satisfactory, composition insulators may offer a solution to the problem.

Current leakage across or through insulators—Wet process porcelain should be free of this trouble unless the surface has acquired a conductive coating. The only remedy for this condition is to clean the insulators according to a schedule established by experience.

Dry process porcelain or composition insulators, may under adverse conditions and extreme moisture, leak electrically either through the insulator or across their surface. This leakage may be high enough to disrupt control circuits or to present a hazard to personnel. A possible means of solution is to clean the insulator and paint the entire insulator and hardware with two coats of Glyptol, selecting a dry day when the leakage current is at an acceptable minimum.

Another form of trouble sometimes found in steel mills where split porcelain insulators are used is the settling of coke breeze between the hook bolt and the

top of the rail. This enters through the crack where the two members of the split porcelain insulator mate. In order to overcome such trouble, insulated hook bolts have been installed, and it is believed that these bolts are contributing to the solution of the problem. The method of insulating the hook bolt is relatively simple. A dilating type of insulation is employed; while the material is dilated, it is slipped over the hook bolt and permitted to contract, thus providing insulation for the hook bolt above the crack between the two porcelain members.

Collector shoe wear—This can sometimes be reduced by decreasing the contact shoe pressure and adding an extra shoe using two or more shoes in parallel.

A graphite lubricant applied to the rail may be of help. Graphite used should be a colloidial graphite suspended in alcohol or a suitable solvent, so that when dry the surface will be conductive and free of any tacky condition.

Collector shunt failure—If this condition is a source of trouble consider the following:

1. Keep all contacts between shunt wire and associated hardware tight and clean.
2. If a cast iron shoe is used, try a bronze shoe in order to improve the contact condition between shoe and shunt.
3. Reduce the current through the shunts by adding an extra shoe.

The subject of current collecting systems is wide in scope. To cover such a subject in so short a space is bound to result in many omissions. By striking some of the high points it is hoped that thinking may be stimulated that will result in the solution of one problem or, perhaps, assist in the selection of a suitable current collecting system.

DISCUSSION

PRESENTED BY

W. H. BOYCE, Manager Industrial Division, Delta-Star Electric Co., Chicago, Ill.

JAMES FARRINGTON, Electrical Superintendent, Wheeling Steel Corp., Steubenville, Ohio

WILLIAM SIEBENMORGEN, Electro Service, Inc., Union City, N. J.

H. YALE MAGEOCH, Chief Engineer, Electric Service Manufacturing Co., Philadelphia, Pa.

W. H. Boyce: We are heartily in agreement with the authors remarks in both the opening and the closing paragraphs. Moreover, we believe a greater attempt should be made by the AISE concerning the entire matter of standardization of collector systems in the steel industry.

Insofar as insulator heights, distances from mounting material, and other pertinent practices are concerned, it is a relatively simple matter to accomplish almost any desired purpose in a new installation. These conditions are difficult to control in the case of an addition to an existing plant or the extension of existing runways. In such instances, the old heights and centers must of necessity be adhered to in order that the cranes on the new extension runway may operate in the same manner as on the existing runway. These conditions apply to the shape and size of the collector as well as to the size and mounting hole dimensions of the collector supports, regardless whether rail, angle iron, or other structural shapes are employed.

The thought occurred to us as far back as twenty-five years ago that possibly something could be done with crane manufacturers along the line of standardization. We soon learned from all the crane builders to whom we broached the subject that they depended almost invariably on the customer for dimension of centers on collector arms and particularly on information as to the types of collectors and insulation to be used on cranes and ore bridges.

There is one point on which we wish Mr. Mageoch had placed more emphasis, and that is the fact that in many cases a high grade of insulation is provided on the main runways, whereas the type of material to be used on the bridges and cranes is left more or less to the discretion of the builder. As a result, we see high grade wet process porcelain or other similar materials used on main runways, and the old standard wooden block used on the crane. The electro-chemical industry has gone further in this respect than the steel companies in insisting on the same type or grade of insulation on the cranes as on the main system.

Mr. Mageoch mentioned the use of non-ferrous collector rails or structural shapes, and specifically the use of aluminum. We have not the slightest doubt that this is absolutely correct and good practice where a crane is in more or less constant use and does not stand idle for protracted periods. We have in mind one or two installations made on small gantry cranes on the locks and dams of the Mississippi River a few years ago, for hoisting the gates under flood conditions. Here aluminum angles were installed. The gantry stood idle for perhaps weeks or months at a time, and when the occasion arose to operate it, it was necessary to scrub off the aluminum oxide with wire brushes before contact could be made.

The old combination of steel rails or steel structural shapes and cast iron shoes has been the most satisfactory down through the years, particularly on heavy current systems. We had a lot of ideas in the early days of combining a non-ferrous with a ferrous member, and found that in Germany they had been making such a combination of steel shapes with a ball head and casting copper around them for conductivity. To our knowledge this procedure has never been followed in this country.

Mr. Mageoch mentioned the ratio of 10 to 1 on carrying capacity of the steel versus the copper conductor, and we agree approximately with this figure. We use 11 to 1; and on that basis the actual carrying capacity of a rail in terms of cm of a copper cable would be 10,000 times its weight per yard. In other words, a 30-pound rail would have the same capacity as a 300,000 cm cable; 50 pounds per yard the same as a 500,000 cm cable; and a 100-pound rail the same as a 1,000,000 cm cable.

We should like to direct a question to Mr. Mageoch. He mentioned that the structural shapes will have a much higher conductivity for a given weight than the steel rail. Assuming roughly the same carbon content in the structural member as in the rail, would it not be

reasonable to assume that the actual conductivity, or resistance, for given sections of equal length with the same cross-sectional area, would be the same?

We heartily concur with Mr. Mageoch in his statements concerning the question of wet and dry process porcelain.

Concerning the question of cold-molded materials. We are not very familiar with them as we have never used them for this purpose in this particular application. We have had disastrous results in applying such materials to other equipment because of moisture absorption as well as their inability to withstand high temperatures.

The phenolic composition insulator with impregnated fibre filler material has been used outdoors as well as indoors, on our recommendation, for more than sixteen years; with so far as we know, satisfactory results. The mechanical strength as well as the electrical characteristics of the present day units are approximately double that of the original units. It is true that carbonization or tracking on a phenolic insulator is a disadvantage. In most cases where insulators are mounted upright, there will not be sufficient dirt accumulation to cause any appreciable surface leakage. On a flashover caused by induced voltage, it will invariably break clear rather than go across the surface. If the insulator is mounted horizontally and has recesses or pockets, complications may result because ore dust and other foreign material can build up; and under these conditions carbonization can occur.

There has been great improvement in the various types of phenolic materials in the past few years, particularly since the war. We formerly considered the theoretical value of 275 F as being the top temperature limit. Now we have materials available that will shortly be on the market, where the phenolic insulator will take not only 400 to 500 F continuously, but also direct flame impingement, as in the case of coke oven installations where it is subjected to these conditions.

Our experience with asbestos has indicated that while it has been extensively used on coke ovens, if it is subjected to direct flame impingement, the binding material is usually burned out and water absorption becomes extremely high, causing trouble from excessive current leakage.

Then there is the question of over-running versus under-running operation, and to that could be added the side contact operation. The application of these methods are feasible and practicable, depending on the customer's preference, provided the insulators are put in compression. They have enormous compression strengths compared to that of cantilever or tension, and in most cases, the type of support selected can be made so that the material is under direct compression rather than cantilever or tension.

We also agree on the question of operation on the higher voltages. In our company's case, invariably the size of the porcelain or the phenolic is such that it would have a minimum rating of 5000 volts, and on 2500-volt operation would have a high factor of safety. The dry flashover voltage will average around 35,000 and will puncture around 42,000 volts.

As to insulator breakages, we believe many of the men here will agree with us that in a number of cases breakage of insulators has occurred through no fault of the installation, the collector system, or the insulator manufacturer. Records indicate that in some cases breakage occurred when insulators were used to support block and falls on collector rails, or when they attempted to support staging or scaffolding from them. Although the resultant breakage was unfortunate, it was due to no fault of the insulation.

To bring out one more example, probably one of the most severe applications occurs on quenching cars collector systems around coke ovens. Apparently there is quite a difference in the chemical makeup of the water in different localities. We have had a number of installations where the standard wet process porcelain insulator has given entirely satisfactory performance, while in other cases it was necessary to hot dip lead coat the hardware instead of hot galvanizing these parts. Also, bronze inserts instead of iron have been used to retard the extreme corrosion prevalent in these localities.

In closing, we again urge more effort by the Association on standardization of collector systems.

James Farrington: In the Figures that were shown of the three collector rail system, the insulators supporting the rails were the type installed at the coke works of the Wheeling Steel Corp.

These collector rails supply 2300-v, 60-cycle, 3-phase current to a 400-kw motor generator set mounted on a 10-ton coal bridge to supply 250-v d-c current.

The collector system is 2800 ft long and has given excellent results in the two years it has been in service.

The division that you saw is due primarily to the fact that we have a 250-v d-c collector system on the other side, for our transfer car purposes, and we were just afraid that some of our men working on the 250-v collector system might get over onto the 2300-v. That is the reason why we separated them. We feed our collector system from three different substations, so that gives us three sources of power in case of trouble. The substations were connected to the collector rails by three oil circuit breakers so we could segregate any part of the 2800 ft system.

We used the split type of rail insulators on our d-c collector system for the ore bridges, and experienced a great deal of trouble due to the possibility of pulling the insulators against the head of the rail and breaking them. We overcame this condition by putting a $\frac{1}{8}$-in. rubber gasket between the tops of insulators so the insulators could not press against the steel rails.

On our 1400-ft, 250-v d-c collector system supplying power to a remote controlled electric pusher, we had low voltage control collector rails furnishing power to the relays in the pusher. The coke dust from the screening station grounded the hook type insulators on the control collector rails, making it necessary to mount the insulators on wood blocks in place of the steel plates, directly under the station only.

Wm. Siebenmorgen: Mr. Mageoch has made out a good case for carbon contacts. However, these carbon contacts at higher riding speeds in transit work leave a good deal to be wished for. The Pennsylvania R. R. made many experiments with carbons on the pantograph, in order to save wear on the trolley. The wear

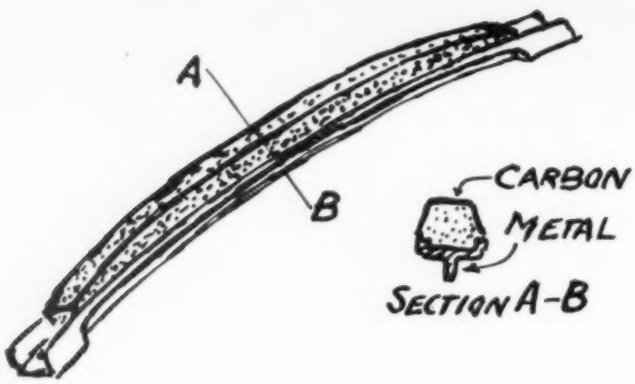


Figure 10 — Sketch shows a design which uses carbon contacts for transit work.

was reduced but the carbon was at least a partial failure. In Europe a carbon contact is used as shown in Figure 10. It sounds well to hear that its life is 100,000 km. However, that is 60,000 miles to us, and the big G G 1 locomotive on the N. Y.-Washington-Harrisburg run, makes more than that in 5 months, and there are more than 100 of them. The European contact sells for around $15.00 over there, that would mean approximately $30.00 here, or over $6.00 per month per contact. The higher domestic speed and the heavier loads would increase the cost still further.

Another example of carbon contact shoes are the carbon inserts in sliding contacts on trackless trolleys. They are used all over the country. They cost 35 to 40 cents a piece and there are 2 per vehicle. They last about 1000 miles. In rainy weather they wear extremely fast for reasons now well known and thereby increasing maintenance cost enormously. A good deal of virgin research will be required to improve carbon applications of the above type.

H. Yale Mageoch: The question on the structural steel conductors was how we arrived at the conductivity figure given. To answer this question, we did not arrive at the conductivity on a cross-section or carbon content basis. We contacted all of the companies producing structural steel requesting that their experts advise us concerning the electrical conductivity of their material. We received many different answers which we added and averaged to arrive at the figure stated.

Mr. Boyce commented on the use of phenolic insulators and I agree that phenolic can be used outside. I do think, in general, that if it is possible for the designer to use porcelain without encountering trouble he is a little better off. Where a user feels that phenolics may apply, if he will consult the manufacturer and get his reaction concerning the use of the material, I am sure that it will be a success.

High temperature plastics are coming. If they are to be purchased now, it would be at a premium. It may be a material employing a glass or silica filler used in conjunction with a binder having higher temperature characteristics than phenolic resin. There are possibilities in the future for the plastic insulator.

CURRENT AISE DISTRICT SECTION MEETINGS

BIRMINGHAM SECTION

Friday, December 15, 1950
Christmas Dinner and Dance
Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Saturday, December 9, 1950
Christmas Dance
Wanakah Country Club, Buffalo, N. Y.

CHICAGO SECTION

Saturday, December 9, 1950
Christmas Dinner and Dance
Sherman Hotel, Chicago, Ill.

CLEVELAND SECTION

Friday, December 15, 1950 — 7:30 P.M. Dinner; 9:00 P.M. Dancing
Christmas Party
Allerton Hotel, Cleveland, Ohio

DETROIT SECTION

Friday, December 8, 1950
Christmas Dinner and Dance
Detroit Yacht Club, Detroit, Mich.

PHILADELPHIA SECTION

Saturday, December 2, 1950 — Dinner 6:00 P.M.; Meeting 7:00 P.M.

"Training of Steel Mill Field Maintenance Personnel," by Clifford W. Burdick, Assistant Electrical Engineer, Lukens Steel Co., Coatesville, Pa.

"Training of Mechanics for Maintenance," by W. F. Scanlon, Supt. of Maint., Alan Wood Steel Co., Conshohocken, Pa.

"Training Operators for Industrial Steam Power Stations," by A. H. Valentine, General Foreman, Pennwood Power Station, Bethlehem Steel Co., Sparrows Point, Md.

Engineers' Club, 1317 Spruce St., Philadelphia, Pa.

PITTSBURGH SECTION

Friday, December 15, 1950 — 7:00 P.M.
Christmas Dinner and Dance
William Penn Hotel, Pittsburgh, Pa.

APPLICATION OF INDUSTRIAL CONTROL RELAYS

By BEN H. CARLISLE, JR.
Project Engineer
The Clark Controller Co.
Cleveland, Ohio

. . . . most relays are combinations of three basic types: voltage relay, current relay, and polarized current relay . . . .

▲ THE purpose of this paper is to describe the operation and application of a few of the more common types of industrial control relays. There is nothing new or unique in any of the relays which we will discuss. They have all been used for many years. However questions as to their operation arise constantly.

All of these relays operate as a result of current or voltage changes in the motor circuit. To form a firm foundation for the discussion which will follow, and at the risk of appearing trite, we will briefly review some of the basic characteristics of d-c motors.

BASIC MOTOR CHARACTERISTICS

The current that flows in the armature of a d-c motor when connected to a constant potential source is a function of two things; namely, the ohmic resistance of the armature circuit, and the counter electromotive force or counter emf, which is built up in the armature. This counter emf results from the fact that the armature conductors are rotating in a magnetic field. Thus it is a function of the strength of the field and the speed of rotation. The polarity of the counter emf is normally (but not always) in such a direction as to oppose the applied line voltage. All of the foregoing can be summarized by the well known equations:

$$I_a = \frac{V - \text{Counter emf}}{R_a}$$

Where: V is the line voltage
I_a is the armature current
R_a is the armature resistance
Counter emf $= K\Phi N$
K is a constant
Φ is the flux in the airgap
N is the speed

These equations tell us a number of things. First of all, if the counter emf is too small, as during acceleration, a heavy current will flow. This can be limited by an increase of field current.

The counter emf is larger than V, such as during deceleration, a reverse current will flow in the armature. This reverse current can be limited by decreasing the field current.

By combining and rewriting the foregoing equations, we obtain:

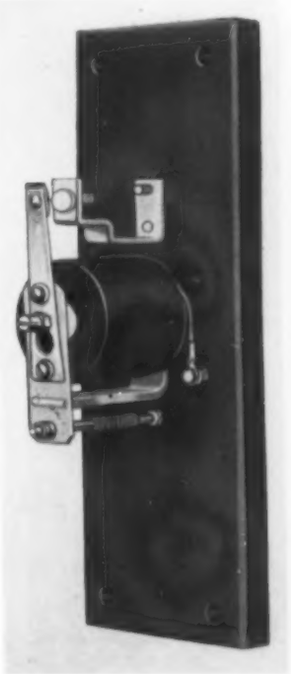


Figure 1 — The field loss or field protective relay is perhaps the simplest type.

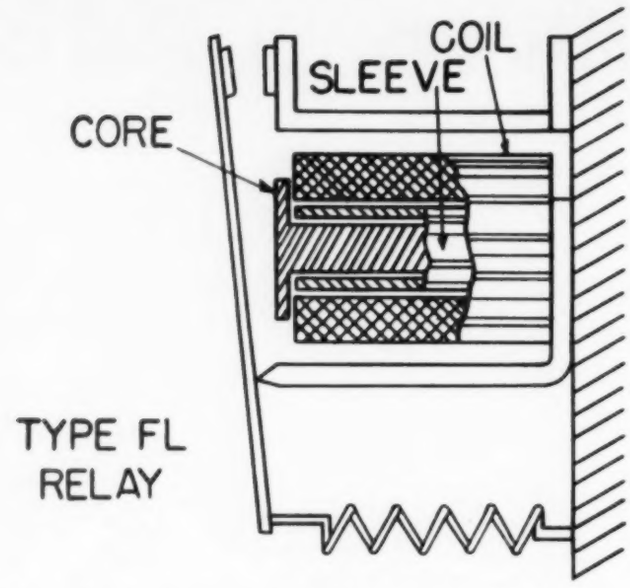


Figure 2 — A non-magnetic sleeve surrounds the core of the field loss relay.

$$N = \frac{V - I_a R_a}{K\Phi}$$

This indicates that motor speed is inversely proportional to field strength. Furthermore it is apparent that a loss of field will cause the motor to run away.

The relays which we will describe are designed to control the foregoing phenomena so as to avoid damage to the motor.

FIELD LOSS RELAY

Perhaps the simplest of the special purpose relays is the field loss or field protective relay, an example of which can be seen in Figure 1. This relay has a normally open contact which is usually connected in series with the coils of the main contactors or in the LV circuit. Its coil is connected in series with the shunt field.

Anyone who has worked around d-c shunt motors is familiar with the results of loss of field excitation. A runaway motor presents grave dangers both to equipment and personnel. The FP (field protective) or FL (field loss) relay, as it is sometimes called, protects against this condition. It makes it impossible to start the motor unless the field is energized and shuts the motor down in case the field opens during operation.

It is common mill practice to provide two such relays, one on either side of the shunt field. Thus the relay also protects for a grounded field.

The coils of these relays must be chosen for the field circuit in which they will work. They must pick up at the minimum field current of the motor but must be capable of handling maximum field current continuously without danger of burnout.

Relays such as these are commonly designed with a time delay dropout feature for use with compound-wound motors. If such a motor is subjected to a sudden and severe overload, the resulting current surge through the series field will "blow out" the shunt field momentarily. This would result in a motor shut down unless the relay is provided with a time delay drop out.

This delay feature is usually obtained by means of a non-magnetic sleeve which surrounds the core (Figure 2). Any tendency of the flux in the core to collapse causes a current to flow in this sleeve. The current in the sleeve sets up a flux which will hold the relay closed for a short period.

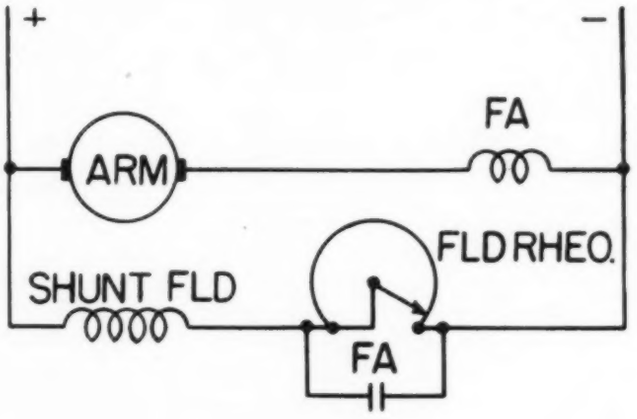


Figure 4 — Basic circuit for field accelerating relay with single series coil.

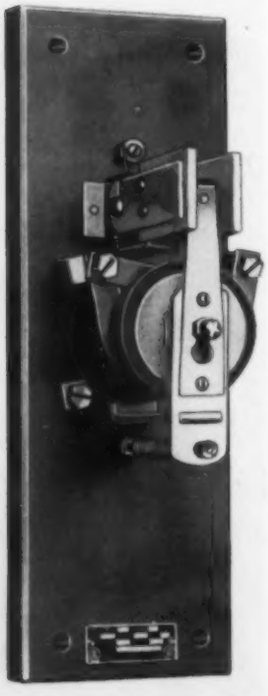


Figure 3 — The field accelerating relay limits currents during periods of acceleration.

THE FIELD ACCELERATION RELAY

The purpose of the field accelerating, or FA, relay is to limit armature current during periods of acceleration. An example of this relay is pictured in Figure 3. It has a normally open contact and a series wound coil which are connected in the circuit as shown in Figure 4.

The relay is designed and adjusted so that its contact will close on currents of about 140 per cent of full load

motor current and will release at about 105 per cent. It is normally applied to shunt motors which have 2 to 1 or greater speed range by field adjustment.

Assume such a motor is running at a relatively low speed with the field rheostat set as shown in Figure 4. The operator suddenly turns the rheostat to the extreme position counter-clockwise. This inserts a relatively high resistance in the field circuit causing the field current, and thus the flux, to decrease. This results in a corresponding decrease of counter emf and a heavy inrush of current. The motor starts to pick up speed. However, the current inrush causes the FA relay to close, shorting out the resistance, which tends to bring the current back to normal. Of course as soon as the current does drop back, the relay reopens and there is another current inrush, an increase of speed etc. This action takes place very rapidly — with the relay fluttering in and out as the motor accelerates. As the motor approaches its new speed level the current inrushes become smaller and finally cease, leaving the relay open.

In addition to this feature of limiting armature current during periods of acceleration by field weakening, it is also desirable to provide full field during start. This is very commonly obtained by means of a full-field relay which shorts out the field rheostat during the starting period. This relay is then released when the last accelerating contactor closes.

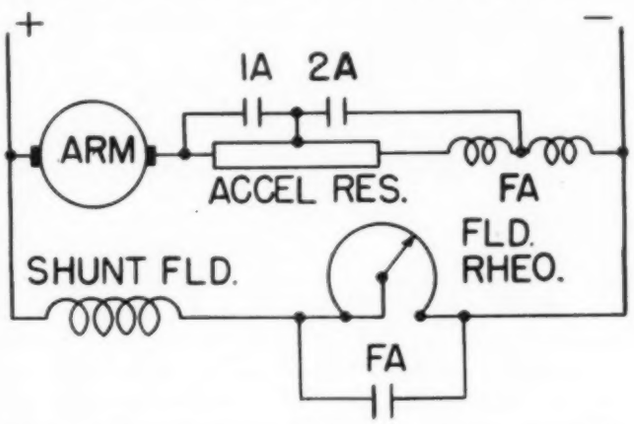


Figure 5 — Basic circuit for field accelerating relay with two series coils.

This same feature can easily be obtained as part of the operation of the FA relay. To do this the relay is provided with two series-wound coils mounted on the core so that their fluxes aid each other. The two coils are connected in series as shown in Figure 5. When the motor is started both coils are active, and the relay will pull in on 60 per cent of full load motor current. Thus as soon as the motor is connected to the line, the relay closes and shorts out the field rheostat. This condition exists until the last accelerator closes. This last contactor shorts out one coil of the relay and from that time on the relay operates as previously described.

Both forms of the FA discussed thus far are non-polarized. That is they will operate equally well regardless of the direction of the current. This is of no consequence in most applications. There are occasions, however, when it would be a disadvantage.

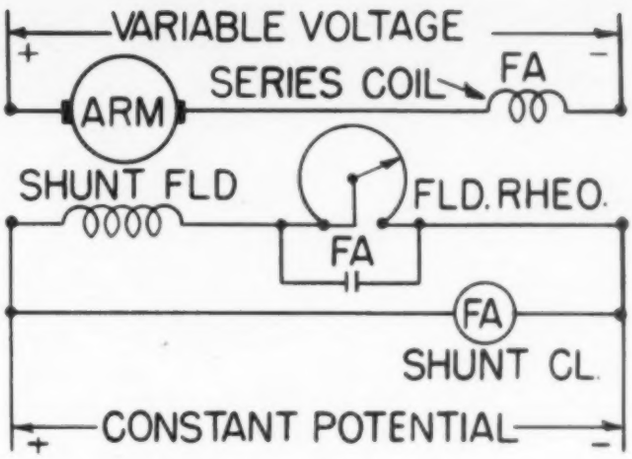


Figure 6 — Basic circuit for field accelerating relay with series and shunt coils.

On variable-voltage controllers it is common practice to brake the motor by reducing the voltage to the armature. The result of this is that the counter emf is greater than line voltage. Therefore regenerative current will flow back through the line. Under this condition it is sometimes desirable to limit this current by maintaining a weak field. If the previous forms of FA relay are used this could not be done. Figure 6 is a diagram showing a polarized FA relay. This relay has a series wound coil in the armature circuit and a shunt-wound coil connected in the constant potential control circuit. The two coils are wound and connected in the circuit so that the fluxes aid each other when the armature current is in the normal direction but they buck each other out when regenerative current is flowing. The relay operates as previously described during acceleration but is inoperative on reverse current.

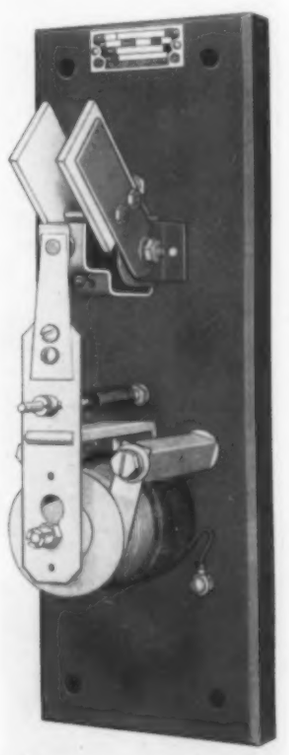


Figure 7 — The field decelerating relay has a normally closed contact.

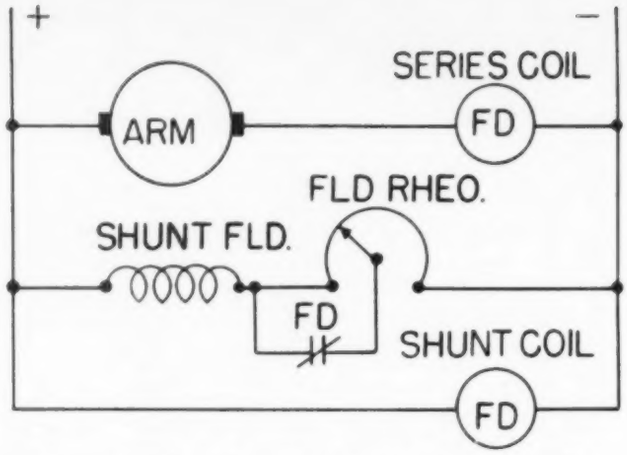


Figure 8 — Basic circuit for field decelerating relay.

THE FIELD DECELERATING RELAY

Another of the field vibrating family is known as the field decelerating, or FD, relay. This relay (Figure 7) is similar to the polarized FA relay except that it has a normally closed contact. It is normally used on motors with 2 to 1 or greater speed ratios and is connected in the circuit as shown in Figure 8, with the series coil in the armature circuit and the shunt coil across the constant potential line. The polarity of these coils are such that they tend to neutralize each other when armature current is flowing in the normal direction but tend to aid each other when reverse current is flowing.

If our motor is running at constant speed with considerable resistance in the field circuit and the operator suddenly turns the rheostat in the "decrease speed" direction, the increased field strength would cause a sudden rise in the value of the counter emf. The counter emf might then exceed the line voltage and cause a current to flow in the armature in a direction opposite to normal. If the counter emf becomes sufficiently large it can result in flashover at the commutator.

The FD relay is set to operate if the reverse current exceeds a 140 per cent of full load. Its operation is very similar to the FA. Its contact opens on each inrush and inserts additional resistance in the field circuit which in turn decreases the armature current causing the contact to close. This action continues until the new speed level is reached.

Relays of this general type are also used to limit reverse current during regenerative braking. There are also circuits wherein reverse current must not flow. In such cases the circuit is arranged so that the motor is shut down completely when the relay opens.

THE NO-LOAD RELAY

There are occasions when it is desirable to shut down a motor in case it loses its load. This is especially true of a wire-drawing machine, where the machine should be immediately stopped if the wire breaks.

A relay to provide this protection must be designed so that it will hold in so long as the motor is appreciably loaded but will drop out at no-load. This offers a problem since the current drawn by an unloaded motor depends on the field excitation. Thus the relay must operate as a function of both armature and field current.

This relay has two coils, one connected in series with the armature; the other in series with the shunt field. They are wound and connected (Figure 9) so they aid each other. Its normally open contact is connected in series with the main contactor. Thus so long as appreciable current is flowing in the armature circuit, the relay remains closed. If the load is dropped armature current decreases, the relay opens and the motor shuts down, regardless of the setting of the field rheostat.

A slight variation of this (Figure 10) provides additional turns on the shunt field coil that can be excited momentarily from the line to cause NL to close and start the motor. Of course once the motor starts the push button can be released.

REVERSING DRIVES

Still another problem of motor protection arises in reversing drives. If a motor is running at constant speed

Figure 9 — Basic circuit for no-load relay without starting coil.

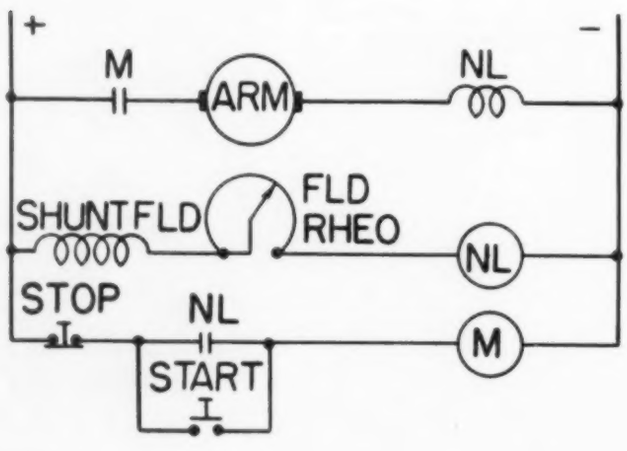
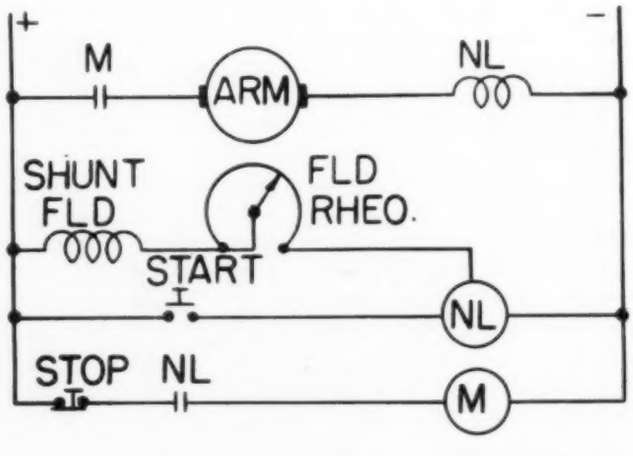


Figure 10 — Basic current for no-load relay with starting coil.



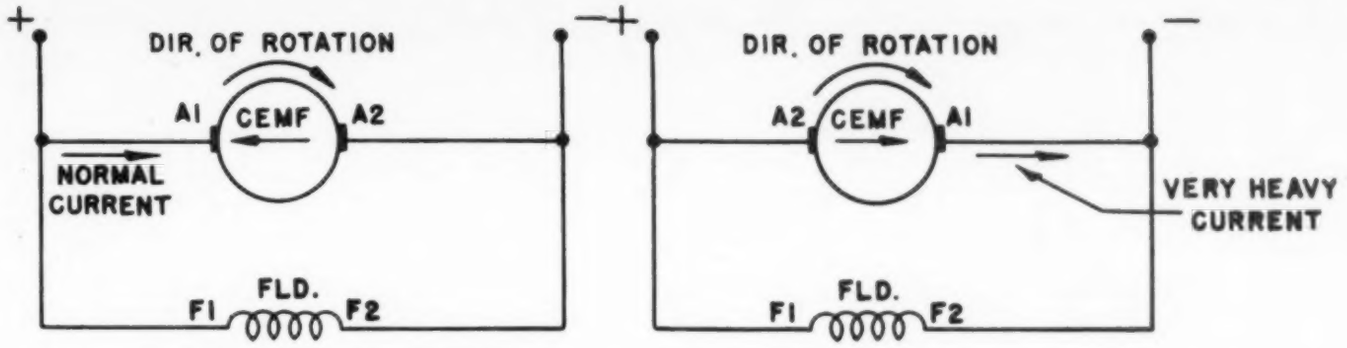


Figure 11 (a on left, b on right) — Sketch shows how dangerously high currents may flow when armature leads are reversed.

in one direction (Figure 11a) the counter emf is nearly equal to and opposing the line voltage. Normal current is flowing. If the armature leads are now suddenly reversed, this counter emf would aid the line voltage and a disastrously large current would flow (Figure 11b). In addition to this severe mechanical shocks may be transmitted to the driven machinery due to the high torques developed.

THE ANTI-PLUG RELAY

The anti-plug, or AP, relay provides one method of protecting a motor from damage during reversal. This relay has a normally closed contact and a shunt-wound coil. The relay is connected in the circuit as shown in Figure 12. It is set to pick up at about 30 per cent of line voltage and drop out at about 10 per cent.

Considering the circuit of Figure 12, assume that the motor is running at full speed in the forward direction. The master switch is at "Fwd." The F contactor and all the accelerators are closed, and the AP relay is open. If the master switch is suddenly thrown to "Rev" the F contactor and all the accelerators will drop out, but R will not pick up because AP is still open. The motor, which is now disconnected from the line, will start to coast to a stop. As it slows down, the counter emf developed across the armature decreases until at about 10 per cent speed, AP is released and its contact closes. This energizes R and the motor accelerates in a normal manner to full speed reverse.

THE PLUGGING RELAY*

Another scheme for protecting a motor during reversal utilizes the plugging relay. One form of plugging relay is shown in Figure 13. This relay consists of two shunt-wound coils mounted on a common frame, and a normally open contact. Figure 14a indicates that whenever the two coils are connected with the same polarity, the flux is forced through the air gap causing the armature, and thus the contact, to close. Figure 14b

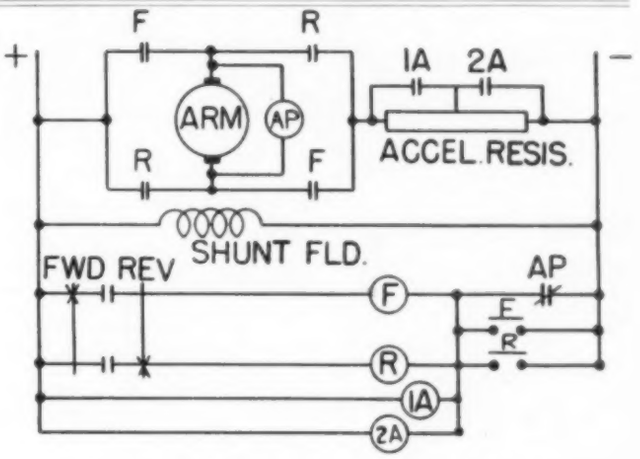


Figure 12 — Basic circuit for anti-plug relay.

shows that if the coils are connected with opposite polarities, the fluxes aid each other, tending to keep

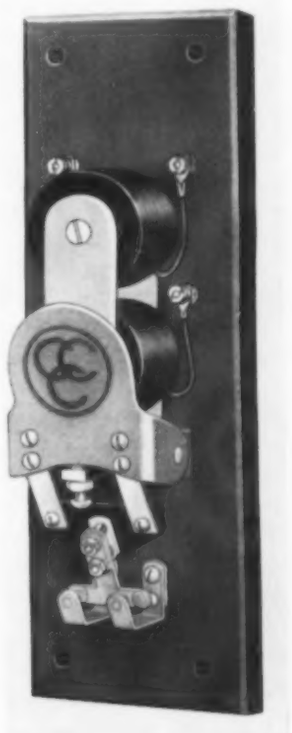


Figure 13 — Plugging relay consists of 2 shunt-wound coils and a normally open contact.

* Published in Electrical Construction and Maintenance, Nov. 1949.

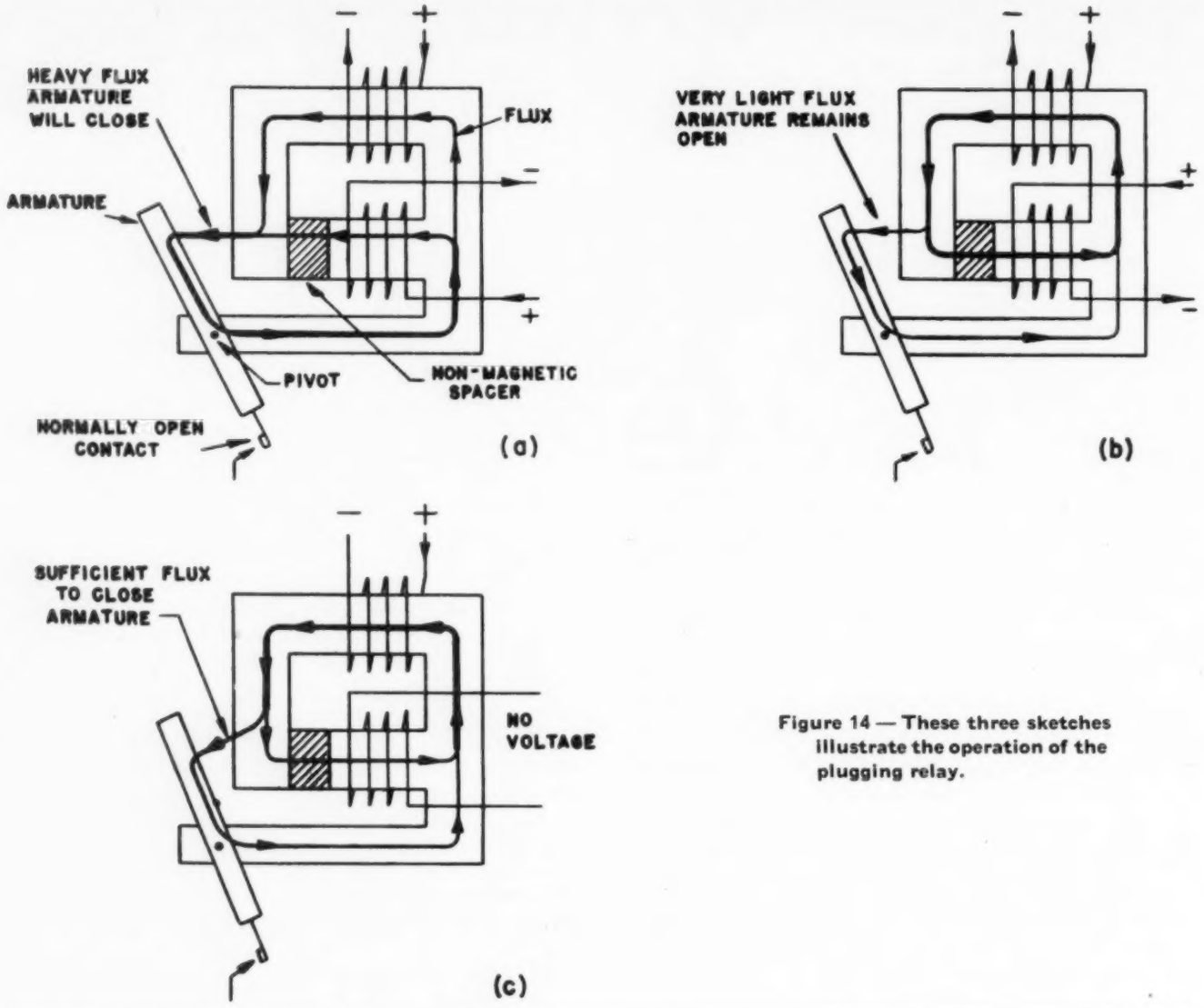
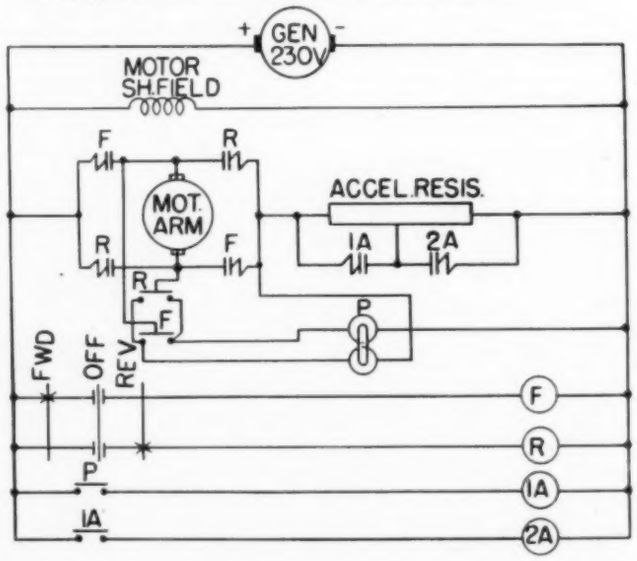


Figure 14 — These three sketches illustrate the operation of the plugging relay.

the flux out of the air gap, and thus the contact remains open. When only the top coil is energized the flux from it splits, a portion passing through the magnetic circuit of the lower coil, the remainder cutting across the air gap (Figure 14c). The ratio of the length of the air gap to the length of the non-magnetic spacer in the lower coil's magnetic circuit is so proportioned that under the above condition, sufficient flux will flow in the air gap to cause the armature to close.

Keeping the above characteristics in mind, refer to Figure 15. If the master switch is placed in the "Fwd" position, the "F" contactor is energized and its control circuit contact closes, applying full voltage to the upper coil of "P" and connecting the lower coil directly across the armature. Thus, since at this instant there is no armature voltage, "P" closes, energizing 1A which shorts out a portion of the accelerating resistor. At the same instant the main contacts of "F" close, connecting the armature to the line in series with the remainder of the accelerating resistor. As the motor picks up speed, the counter emf builds up in the armature and this voltage is applied to the lower coil of "P." Since the polarity of this voltage is the same as that applied to the upper coil, "P" continues to hold in. When 1A closed, its auxiliary contact energized the coil of 2A. However, 2A is a timing contactor and its contact closes only after a definite delay, shorting out the balance of

Figure 15 — This sketch illustrates the operation of the plugging relay as the motor picks up speed.



the accelerating resistor, and bringing the motor up to full speed. A simplified diagram of the circuit when the motor is running at full speed is shown in Figure 16.

If the master switch is now swung from "Fwd" to "Rev," "F," "P," "1A" and "2A" all drop out as the master passes through the off position, inserting all of the accelerating resistance in series with the armature. "R" is energized when the master reaches the "Rev" position and its auxiliary contact reconnects the coils of "P." Full line voltage is applied to the upper coil of "P" and the counter emf developed in the armature is applied to the lower coil. However, since these voltages are applied with opposite polarities, "P" remains open, Figure 17. The motor now starts to decelerate and the counter emf decreases. When the motor reaches zero speed, the voltage applied to the lower coil becomes zero and "P" closes bringing in "1A." The motor now accelerates to full speed in the reverse direction exactly as it did in the forward direction. It is well to note that the operation would be identical if the master switch were thrown from "Rev" to "Fwd."

There are, of course, a great many other special purpose relays. Plugging, for instance, is often obtained by using two separate voltage relays, one of which is operative in the forward direction only, the other in reverse. Plugging is also obtained by a wide variety of mechanical switches mounted on the motor shaft.

A great many of the relays encountered in practice will be merely variations of three basic types that we have described — the voltage relay, the current relay, and the polarized current relay.

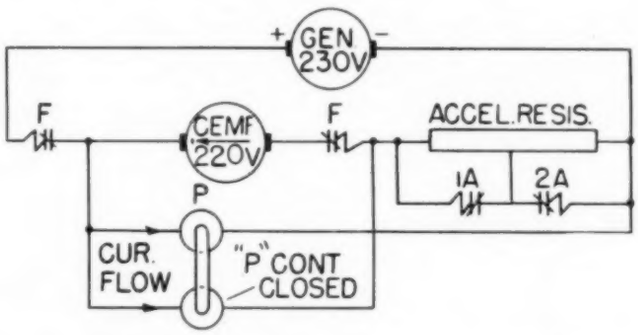
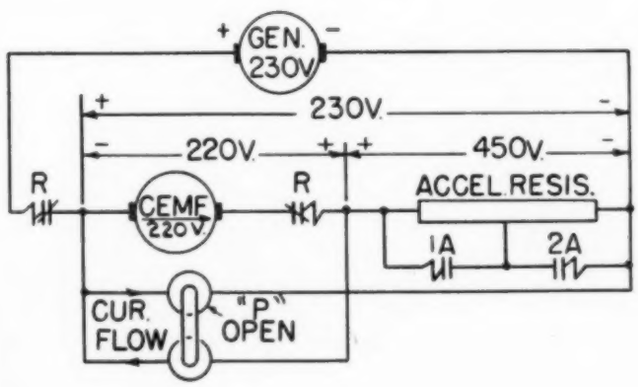


Figure 16 — Simplified diagram of circuit when motor is running at full speed.

Figure 17 — Sketch shows operation of plugging relay when the master switch is moved to the reverse position.



DISCUSSION

PRESENTED BY

E. F. ALLBERT, Control Engineer, Westinghouse Electric Corp., Buffalo, N. Y.

BEN H. CARLISLE, JR., Project Engineer, The Clark Controller Co., Cleveland, Ohio.

J. C. ANTHONY, Industrial Control Engineering, Westinghouse Electric Corp., Buffalo, N. Y.

G. E. MATHIAS, Heavy Mill Section, Industrial Control Engineering, Westinghouse Electric Corp., Buffalo, N. Y.

JOHN A. CORTELLI, Chief Engineer, Clark Controller Co., Cleveland, Ohio.

E. F. Allbert: There was one value in which I was interested. On the accelerating relay, you used 125 per cent as the pickup value of the current coil. How critical is this?

Ben H. Carlisle, Jr.: That is not a critical value. It will vary from 125 to 135 per cent.

J. C. Anthony: I noticed that you had a higher pickup value for FD (field decelerating) relay than for FA (field accelerating) relay. Is there any particular reason for that?

Ben H. Carlisle, Jr.: No, it has been found from practice that 140 per cent is a good value for pickup. You make it pickup at a somewhat higher value than FA.

G. E. Mathias: On your field loss relay you speak of having pickup at minimum field excitation. What is the dropout value?

Ben H. Carlisle, Jr.: This relay has a rather broad differential. It holds in down to a minimum of 65 per cent of pickup value.

G. E. Mathias: You speak of the time there, too. Could you give us a definite value of how much that is, or is that an elusive figure?

Ben H. Carlisle, Jr.: It is about a quarter of a second after de-energization.

John A. Cortelli: I would like to elaborate on one point on the field loss relay. We ran some tests recently, to determine that time delay and its runs in the neighborhood of 10 to 12 cycles on a 60-cycle wave. That is the maximum time the relay will hang in, and it will vary all from 5 to 12, depending on the saturation; you do not dare delay them too long.

J. C. Anthony: Do you use field loss relays with all compound motors and if not, what is the dividing line?

Ben H. Carlisle, Jr.: You can run into trouble with a highly compounded motor during start. During the starting period, you can blow out the shunt field and stop the motor before you start. There are a number of ways, of course, of getting around that. One method would be to short out the contact on the field loss relay during start. Another would be to have an additional series coil on the field loss relay, connected in the armature circuit, and which would be shorted out by the last accelerating contactor.

COKE AND BY-PRODUCTS IN 1949

. . . . data from Mineral Market Reports, M.M.S. No. 1879, June 1950, M.M.S. No. 1912, September 1950, and Bureau of Mines Information Circular 7579, September 1950 . . . .

▲ THE production of coke in the United States in 1949 decreased 15 per cent from the record established in 1948 according to the Bureau of Mines, United States Department of the Interior. This drastic reduction was due principally to (1) slackening in steel demand in the second quarter of the year, (2) initiation of a 3-day work week at bituminous-coal mines in July, and (3) complete work stoppages for various periods in both the steel and bituminous-coal industries in the last quarter. The rate of coke production at oven-coke plants started to decline slightly in the last half of March and dropped to the lowest figure since May 1946 in October, because the steel strike beginning at midnight September 30 forced virtually all "furnace" oven-coke plants to bank their ovens until a new management-labor contract was negotiated about the middle of November. As a result annual oven-coke production declined 12 per cent from the 1948 total. Beehive-coke operations were affected to an even greater extent as the 3-day work week, beginning in July, caused practically all of the active plants to suspend operations for the rest of the year and production dropped 48 per cent.

Construction of new coke ovens continued at a rapid pace in 1949, and 469 new ovens with an annual coke capacity of 2,275,300 tons were completed and placed in operation. Attention is directed to the fact that in spite of all the new construction, the total number and annual coke capacity of slot-type ovens in existence on December 31 were lower than at the beginning of the year. It is evident that new construction did not keep pace with obsolescence and old oven failures. Thus, if oven-coke capacity is to be maintained at the current or slightly higher level, construction of replacement and new capacity will have to be continued on a large scale because of the great number of ovens 25 years or older. The large number of slot-type coke ovens under construction at the close of the year is indicative that oven-coke plant operators are taking vigorous action to meet future coke requirements.

Production of the principal coal-chemical materials —gas, tar, ammonia, and crude light oil—which invariably accompany the production of oven coke, all showed decreases when compared with 1948 figures. Coke-oven gas production declined 11 per cent; tar 9 per cent; ammonia in terms of sulphate equivalent, 9 per cent; and crude light oil, 11 per cent. It is to be noted, however, that although the total production of these materials decreased, the average yields per ton of coal carbonized increased slightly, indicating an improvement in coal quality. The total value of coke and breeze produced and coal-chemical materials sold exceeded a billion dollars for the third consecutive year, and was $1,110,653,140.

PRODUCTION OF COKE

In 1949 the average daily rate of by-product coke was 165,000 tons; the average daily production in beehive ovens was 9,350 tons. The leading states in order of importance in manufacture of by-product coke were Pennsylvania, Ohio, Indiana, New York, and Alabama. New York just nosed out Alabama which was in fourth place in 1948. These five states combined produced about 41,540,000 tons or 68.9 per cent of the national production of oven coke. The leading producer of beehive coke was Pennsylvania with 2,898,683 tons or 85 per cent of the total beehive production. Of all the coke produced, Pennsylvania was by far the leading producer with 17,667,492 of the total 63,637,429 tons or 27.8 per cent. This was a slight drop from the 30 per cent share which Pennsylvania had had in 1948.

NUMBER AND CAPACITY OF OVENS

At the end of 1949 there were 15,104 by-product ovens in existence with a total capacity of 73,710,100 net tons. This is a slight drop from the 15,139 ovens with a capacity of 74,499,900 tons at the end of 1948. During the year, 469 new ovens with a capacity of 2,275,300 tons were completed and 562 were under construction with a capacity of 3,275,000 net tons. There were 13,662 beehive ovens in existence at the end of the year with a capacity of 8,762,200 net tons. About 504 slot-type ovens and 647 beehive coke ovens were abandoned during the year. All of the beehive ovens abandoned were in Pennsylvania.

Although iron and steel companies have been engaged in a tremendous coke-oven building program since the early 1940's, blast furnace capacity also has grown, and their coking capacity has not increased sufficiently to supply metallurgical coke for maximum blast furnace operations. For this reason it has been necessary to draw coke from beehive, merchant, and gas-utility coke plants to meet iron blast furnace coke requirements.

COAL CHARGED INTO COKE OVENS

In 1949, 91,408,896 net tons of coal were charged into coke ovens. Of this total, 86,054,401 tons valued at $733,346,608 or $8.52 a ton were charged into by-product coke ovens, and 5,354,495 tons valued at $29,043,896 or $5.42 a ton were charged into beehive ovens. Included in this figure are 172,825 tons of anthracite valued at $1,269,973 ($7.35 a ton) which were charged into by-product coke ovens.

The cost of coal (1.43 tons) required to make one ton of by-product coke was $12.18 in 1949. Similarly the cost of coal (1.57 tons) required to make one ton of beehive coke was $8.50 a ton. This is up from the $11.58 and $8.02 per ton in 1948. The trend towards washed coal continues and of the 86,054,401 tons of coal charged into by-product ovens, over 32,647,324 tons were washed compared with 28,529,290 tons in 1948. At the beehive ovens, 1,065,030 tons were washed of the 5,354,495 tons charged.

The leading states in mining coking coal in order of importance are West Virginia, Pennsylvania, Kentucky, and Alabama. Of the 85,679,724 tons of coal produced, West Virginia produced 32,638,773 tons; Pennsylvania, 27,371,938 tons; Kentucky, 11,316,015 tons; and Alabama the fourth state produced 7,065,913 tons.

COKE PRODUCED AND SOLD OR USED BY PRODUCERS

The total quantity of coke reported used in blast furnaces was 51,356,617 tons or 81.3 per cent of the total. This is less than the 59,128,129 tons used in 1948. The coke used per net ton of pig iron and ferroalloys was 1,895.8 lb compared with 1,937.2 lb in 1948. The yield was thus 70.0 per cent as 2,708.3 lb of coking coal was used per net ton of pig iron and ferroalloys. The comparable figure of the American Iron and Steel Institute of 1,870.4 lb of coke per net ton of pig iron in 1949 excludes the furnaces which make ferroalloys. The total sales of by-product and beehive coke to other than affiliated companies for blast furnace use was 4,649,226 tons. Coke cold for domestic fuel was 2,755,840 tons.

STOCKS OF COKE AND COKING COAL

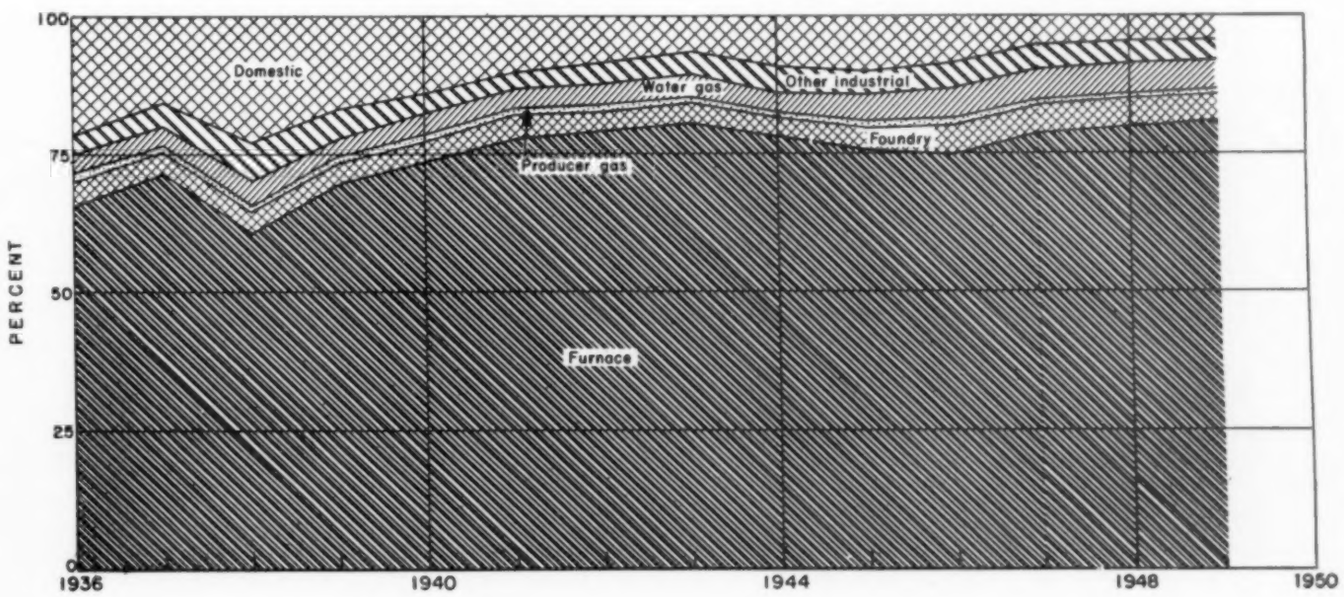
According to reports from by-product coke plants as of January 1, 1950, stocks of furnace and foundry coke totaled 851,838 tons, domestic and other coke stocks totaled 864,720 tons and the stock of coke breeze was 1,433,289 tons. This is a slight drop in the stock level for furnace and foundry coke and an increase in the level of domestic coke from the previous year. Stocks at beehive coke plants were much less and coke for furnaces and foundries at these plants totaled 52,698 tons; domestic and others totaled 200 tons and stocks of coke breeze totaled 7,327 tons.

The continued labor troubles in the coal industry prevented the usual pattern of coal stocks following the trend of monthly production. Bituminous coal stock at oven coke plants varied from a low of 9,892,891 tons in December 1949 to a high of 15,870,342 tons in May 1949.

GROSS VALUE IN YIELD OF BY-PRODUCTS

The gross value of by-products sold in 1948 (exclusive of the value of tar used by producer and the value of coke breeze produced) was $238,720,731 or 28.3 per cent of the gross value of the coke produced. The average yield of the primary coke by-products increased in 1949 over 1948. In 1949 the average yield of tar increased from 7.60 to 7.81 gal per ton of coal, ammonium sulphate or equivalent increased from 19.52 to 20.08 lb per ton; crude light oil increased from 2.73 to 2.77 gal per ton and the average yield of gas increased from 10.23 to 10.25 M cu ft per ton.

Figure 1 — Percentage distribution of oven and beehive coke by principal uses 1936-1949 exclusive of breeze.



DISTRIBUTION OF OVEN AND BEEHIVE COKE

The 15 per cent reduction in coke output in 1949 from 1948 resulted in a corresponding decrease in the quantity of oven and beehive coke distributed. The movement of coke (63,462,233 tons) would have been higher had more been available, as there was a strong demand from industry. Beehive coke ovens were especially affected and the proportion of coke supplied by them to total output decreased from 9 per cent in 1948 to 5 per cent in 1949. The decline in production of oven and beehive coke reduced supplies in some areas during the latter part of the year and some industrial plants had to obtain part of their requirements from greater distances. Although 1949 figures on the average haul for all coke shipped by rail, the principal method of movement, are not available, it was no doubt considerably higher than the 182.44 miles reported for 1932 in Freight Traffic Report, Appendix No. 1, issued by the Federal Coordinator of Transportation. Although blast furnace coke is not normally transported as far as foundry or other industrial coke, there were shipments from Texas to the Chicago area and from the Eastern Seaboard to the Pittsburgh-Youngstown district.

The outstanding feature in the coke trade since World War II is the upward trend in coke requirements for metallurgical purposes. Figure 1 shows this trend graphically and also illustrates the declining market for domestic coke. The tonnage of coke destined to iron blast furnaces in 1949 decreased 13 per cent from the 1948 record but the proportion used increased from 80 per cent of the total for all purposes in 1948 to 82 per cent. Consumption of foundry coke in 1949 declined 26 per cent from 1948 but was 67 per cent higher than the 1935-39 average. A drop of 11 per cent was registered in the use of coke for producer gas and water gas manufacture, and the quantity involved represented 7 per cent of total shipments. Growth in the use of coke for water gas manufacture since 1940 is significant, due in part to the increasing use of water gas as a fuel and also as a starting material for chemical synthesis. It is estimated that in 1949 more than 40 per cent of the quantity of coke used to manufacture water gas was used for the latter purpose. The quantity of coke classified as other industrial (non-ferrous smelting, chemical processing, and miscellaneous other purposes) declined 36 per cent from 1948 and was equivalent to 3 per cent of the national total. Demand for coke for domestic heating has been steadily losing ground in the past decade, dropping from 14 per cent of total shipments in 1940 to but 4 per cent in 1949. The tonnage shipped for household heating was the lowest since 1923.

CONSUMPTION BY STATES

As coke is the principal fuel used in smelting iron ore, states having the greatest concentration of blast furnaces are naturally leading coke-consuming states. Thus, Pennsylvania with a preponderance of blast furnace capacity leads all states in coke consumption, and in 1949 accounted for 25 per cent of the national total; Ohio, second in coke consumption, used 16 per cent followed by Indiana with 10 per cent; New York and Illinois with 8 per cent each; and Alabama with 7 per cent of total consumption. Other states which consumed more than 2 million tons of coke in 1949 were Maryland, Michigan and West Virginia which together consumed 12 per cent of the total.

Blast furnace coke was consumed in 18 states in 1949, and Pennsylvania alone accounted for 30 per cent of the total used for that purpose. Blast furnaces in Ohio and Indiana together required about the same tonnage, and Illinois, Alabama and New York combined used 23 per cent of the total. Thus, these six states consumed 82 per cent of the total blast furnace coke used in the United States. The use of foundry coke is widespread and all states received coke for this purpose. Michigan continued to lead all states in foundry-coke consumption with 19 per cent of the total. Ohio, Pennsylvania and Illinois followed, and together accounted for 30 per cent of the total foundry coke distributed. Of the 8 states using coke for the manufacture of producer gas, New York consumed 37 per cent and Massachusetts and New Jersey together used 29 per cent of the total. New York and West Virginia combined consumed 50 per cent of all coke delivered to 27 states for the manufacture of water gas. It is to be noted that the manufacture of water gas in these two states is for two distinctly separate purposes. In New York, virtually all of the water gas is used as fuel, whereas in West Virginia, water gas is the starting point in the manufacture of chemicals. Significant tonnages of coke also were distributed for the manufacture of water gas in New Jersey, Virginia and Ohio, the sum of which represented 29 per cent of the total. Coke designated as other industrial was shipped to every state, except South Dakota, with New York, Michigan, Pennsylvania and Ohio accounting for 45 per cent of the total. Domestic coke (generally used for space heating) was shipped to all, but 11 states and the District of Columbia, with New York, Massachusetts, New Jersey and Michigan consuming 54 per cent of the total.

COMPARATIVE CONSUMPTION, 1940 AND 1949

Consumption of coke for all purposes in 1949 when compared with 1940 gained in 5 of the 9 geographic regions. The over-all decline in New England, Michigan, Missouri Valley, and Lake Dock regions was due to the decline in the use of domestic coke which was not offset by gains in consumption for metallurgical purposes. The highly industrialized Middle Atlantic region consumed 41 per cent of the coke distributed in 1949, largely because of the quantities of blast-furnace coke used in Pennsylvania, New York and Maryland. This region leads in the consumption of coke classified as other industrial as well as that used for household heating. The latter use decreased 63 per cent from 1940, principally because of the huge reduction in New York. Expansion of heavy industry in the Chicago area in the past decade enabled the Illinois-Indiana region to supplant Ohio as the second largest region in coke consumption. The largest percentage increase registered in the past 10 years was in the Southwest, Mountain, and Pacific region with a gain of 183 per cent between

TABLE I

Statistical Trends of the Coke Industry in the United States

	1937	1946	1947	1948	1949
Production:					
Oven coke, net tons	49,210,748	53,929,447	66,758,549	68,284,357	60,222,481
Beehive coke, net tons	3,164,721	4,568,401	6,687,301	6,577,571	3,414,948
Total, net tons	52,375,469	58,497,848	73,445,850	74,861,928	63,637,429
Per cent oven coke	94.0	92.2	90.9	91.2	94.6
Stocks of coke, end of year, net tons	2,595,287	928,766	1,032,237	1,593,441	1,769,456
Exports, all coke, net tons	526,683	1,231,327	835,059	706,190	548,256
Imports, all coke, net tons	286,364	52,188	104,093	161,400	277,507
Indicated consumption, all coke, net tons	51,271,929	57,321,756	72,611,413	73,755,934	63,190,665
Disposal, all coke sold or used:					
Furnace coke, net tons	36,751,969	43,700,492	57,636,505	59,285,506	51,514,853
Foundry coke, net tons	2,038,822	2,996,202	3,650,001	3,750,659	2,778,868
Other industrial coke (including producer and water gas), net tons	4,597,894	6,593,870	8,028,791	7,733,382	6,412,672
Domestic coke, net tons	8,107,518	5,096,733	3,977,328	3,445,309	2,755,840
Carbonizing equipment:					
Coke ovens in existence, end of year	12,718	14,494	14,728	15,139	15,104
Beehive ovens in existence, end of year	12,194	12,864	13,443	14,078	13,662
Coke ovens under construction, end of year	259	824	572	350	562
Cost of coal charged, oven-coke plants, average per ton	$3.74	$5.77	$6.78	$8.13	$8.52
Prices of coke:					
Average spot price of Connellsville furnace coke, fob ovens	$4.29	$8.13	$10.49	$13.44	$13.77
Average realization on oven coke sold (merchant sales):					
Furnace coke	$4.34	$8.85	$10.95	$13.78	$14.09
Foundry coke	$8.47	$12.62	$14.79	$18.78	$19.72
Other industrial coke (including water gas)	$6.08	$9.58	$11.13	$13.45	$13.74
Domestic coke	$6.53	$9.90	$11.19	$13.17	$13.50
Yield of by-products per ton of coal charged:					
Tar, gal	8.67	7.82	7.78	7.60	7.81
Ammonium sulphate or equipment, lb	21.84	19.79	19.66	19.52	20.08
Crude light oil, gal	2.86	2.77	2.75	2.73	2.77
Surplus gas sold or used, M cu ft	6.66	6.29	6.27	6.25	6.35
Average gross receipts for by-products, per ton of coke produced:					
Tar sold and used	$0.502	$0.466	$0.605	$0.828	$0.722
Ammonia and its compounds	$0.326	$0.361	$0.423	$0.545	$0.558
Crude light oil and its derivatives (including naphthalene)	$0.435	$0.467	$0.566	$0.685	$0.673
Surplus gas sold or used	$1.483	$1.542	$1.678	$1.839	$2.015
Total coal-chemical materials (including breeze)	$2.974	$3.207	$3.710	$4.419	$4.447

1940 and 1949. This was due almost entirely to the increase in blast furnace coke consumption in Texas, Colorado, Utah and California as uses for other purposes have not varied greatly. This region accounted for 4 per cent of the large coke consumption in 1949 compared with 2 per cent in 1940. The largest gain, tonnagewise, was registered by the Southeast region with an increase of more than 2 million tons (32 per cent) over 1940.

EFFECT OF NATURAL GAS

Development of high-pressure transcontinental gas-transmission systems in the United States has made natural gas available to markets many miles distant from producing fields. Increasing demand for natural gas and the greater availability of steel are accelerating the construction of new pipe lines, and natural gas service is extending rapidly into many new areas. In some localities coke-oven gas has already been displaced, and contemplated new pipe lines will extend to other areas where coke-oven gas is currently distributed by city gas utilities. To determine what effect the introduction of natural gas into certain areas might have on the production of oven coke, coke-oven gas, and coal chemicals, the Bureau of Mines conducted a survey of all oven coke plants operated by gas utilities, commercial or merchant companies, and merchant pig iron producers. This study did *not* include coke plants *integrated with steel plants* nor coal-gas plants operating gas retorts.

The coke plants most likely to be affected by the introduction of natural gas into an area are those classified by the Bureau of Mines as gas utilities and merchant operations. The quantities of coke and coal chemicals produced by these plants are substantial, although there has been a steady decline in proportion of coal products produced by them to the national total. In 1948, the output of coke from these plants totaled 13,332,499 net tons, or nearly 20 per cent of the total oven coke produced in the United States. All of the plants that contributed to this tonnage were canvassed to determine the possible effect that the substitution of natural gas for coke-oven gas might have on their continued operations. The replies were analyzed, and the result indicated that five plants and one battery at another, which operated in 1948, expect to discontinue operations as soon as natural gas is introduced. These plants, which operated 310 ovens with an annual coke capacity of 1,298,400 net tons, produced 1,285,371 tons of coke in 1948. Thus, about 10

TABLE II

Salient Statistics of the Coke Industry in the United States in 1949

		By-product	Beehive ovens	Total
Coke produced — At merchant plants	net tons	12,112,922	.....	.....
At furnace plants	net tons	48,109,559	.....	.....
Total	net tons	60,222,481	3,414,948	63,637,429
Screenings or breeze produced	net tons	4,929,086	59,494	4,988,580
Coal charged into ovens	net tons	86,054,401	5,354,495	91,408,896
Average value of coal per ton		$8.52	$5.42	$8.34
Average yield in per cent of total coal charged —				
Coke		69.98	63.78	69.62
Breeze (at plants actually recovering)		5.76	3.53	5.72
Ovens — In existence January 1		15,139	14,078	29,217
In existence December 31		15,104	13,662	28,766
Dismantled during year		504	647	1,151
In course of construction December 31		562	.....	562
Annual coke capacity, December 31	net tons	73,710,100	8,672,200	82,382,300
Coke used by producer — In blast furnaces	net tons	35,046,393	67,518	35,113,911
In foundries	net tons	80,395	.....	80,395
To make producer gas	net tons	790,910	.....	790,910
To make water gas	net tons	1,313,785	.....	1,313,785
For other purposes	net tons	356,298	1,779	358,077
Coke sold — To financially affiliated companies —				
For blast furnace use	net tons	10,656,809	1,094,907	11,751,716
For foundry use	net tons	52,433	.....	52,433
For manufacture of water gas	net tons	721,076	.....	721,076
For other purposes	net tons	192,713	554	193,267
To other consumers —				
For blast furnace use	net tons	2,950,619	1,698,607	4,649,226
For foundry use	net tons	2,446,160	199,880	2,646,040
For manufacture of water gas	net tons	1,267,885	114,973	1,382,858
For other industrial use	net tons	1,452,791	199,908	1,652,699
For domestic use	net tons	2,740,987	14,853	2,755,840
Disposal of screenings or breeze —				
Used by producer — For steam	net tons	3,199,101	1,141	3,200,242
To make producer or water gas	net tons	116,436	.....	116,436
For other purposes	net tons	722,308	9	722,317
Sold	net tons	1,055,459	35,531	1,090,990
Average receipts per ton sold (merchant sales)				
Furnace coke		$14.09	$13.29	$13.80
Foundry coke		$19.72	$15.26	$19.38
Water-gas coke		$13.51	$14.00	$13.56
Other industrial coke		$13.94	$13.54	$13.90
Domestic coke		$13.50	$11.80	$13.49
Screenings or breeze		$3.89	$1.93	$3.83
Stocks on January 1, 1950:				
Furnace coke	net tons	838,718	51,580	890,298
Foundry coke	net tons	13,120	1,118	14,238
Domestic and other coke	net tons	864,720	200	864,920
Screenings or breeze	net tons	1,433,289	7,327	1,440,616
Exports	net tons	(1)	(1)	548,256
Imports	net tons	(1)	(1)	277,507
Indicated consumption	net tons	(1)	(1)	63,190,665
By-products produced — Tar	gal	672,407,370	.....	672,407,370
Ammonium sulphate or equivalent	lb	1,695,611,937	.....	1,695,611,937
Gas	M cu ft	882,309,827	.....	882,309,827
Burned in coking process	per cent	36.77	.....	36.77
Surplus sold or used	per cent	61.90	.....	61.90
Wasted	per cent	1.33	.....	1.33
Crude light oil	gal	228,754,333	.....	288,754,333
Yield of by-products per ton of coal —				
Tar	gal	7.81	.....	7.81
Ammonium sulphate or equivalent	lb	20.08	.....	20.08
Gas	M cu ft	10.25	.....	10.25
Crude light oil	gal	2.77	.....	2.77
Coal used per ton of coke	tons	1.43	1.57	1.44
Value of coke at ovens		798,792,069	43,945,627	842,737,696
Value of screenings or breeze		16,935,000	129,436	17,064,438
Value of by-products sold — Tar sold		$31,314,137	.....	$31,314,137
Used by producer		$12,130,275	.....	$12,130,275
Ammonia (sulphate and liquor)		$33,590,544	.....	$33,590,544
Gas (surplus)		$121,378,832	.....	$121,378,832
Crude light oil and derivatives		$37,862,825	.....	$37,862,825
Other coal-chemical materials (2)		$14,574,393	.....	$14,574,393
Total value of coke and breeze produced and coal-chemical materials sold (3)		$1,066,578,077	$44,075,063	$1,110,653,140

(1) Not separately recorded. (2) Naphthalene, tar derivatives, and miscellaneous coal-chemical materials.
(3) Includes value of tar used by producer.

TABLE III

Coke produced, value, number of ovens, coal charged, and average yield in the United States in 1949, by States (Exclusive of screenings or breeze)

State	Oven coke						
	Plants	Ovens	Coal charged (net tons)	Yield of coke from coal (per cent)	Coke produced (net tons)	Value of coke at ovens	
						Total	Per ton
Alabama	7	1,311	7,282,457	70.87	5,161,397	$55,493,394	$10.75
California	1	135	578,484	59.91	346,552	(1)	(1)
Colorado	1	266	1,095,247	66.61	729,516	(1)	(1)
Illinois	8	900	4,590,854	69.61	3,195,645	52,258,356	16.35
Indiana	5	1,871	10,437,884	72.17	7,533,290	122,527,774	16.26
Maryland	1	483	2,839,947	71.83	2,039,957	(1)	(1)
Massachusetts	1	204	1,264,638	70.49	891,400	(1)	(1)
Michigan	4	568	3,480,364	71.38	2,484,409	34,773,316	14.00
Minnesota	3	196	1,098,718	71.17	781,943	12,693,926	16.23
New Jersey	2	341	1,838,202	73.17	1,345,094	(1)	(1)
New York	8	1,142	7,389,691	69.89	5,164,790	69,074,052	13.37
Ohio	15	2,248	12,688,184	70.23	8,911,140	111,443,394	12.51
Pennsylvania	13	3,730	21,647,307	68.22	14,768,809	179,838,346	12.18
Tennessee	1	44	304,913	69.98	213,378	(1)	(1)
Texas	2	125	709,108	70.09	497,019	(1)	(1)
Utah	2	308	1,466,527	61.49	901,829	(1)	(1)
West Virginia	5	718	4,519,527	70.42	3,182,857	34,370,765	10.80
Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin	6	514	2,822,349	73.47	2,073,456	29,838,358	14.39
Undistributed	.....	.....	.....	.....	.....	96,480,388	13.85
Total 1949	85	15,104	86,054,401	69.98	60,222,481	798,792,069	13.26
At merchant plants	30	3,057	16,960,295	71.42	12,112,922	181,084,964	14.95
At furnace plants	55	12,047	69,094,106	69.63	48,109,559	617,707,105	12.84
Total 1948	86	15,139	97,240,318	70.22	68,284,357	848,719,083	12.43

State	Beehive coke						Total	
	Ovens	Coal charged (net tons)	Yield of coke from coal (per cent)	Coke produced (net tons)	Value of coke at ovens		Coke produced (net tons)	Value of coke at ovens
					Total	Per ton		
Alabama	.....	.....	.....	.....	.....	.....	5,161,397	$55,493,394
California	.....	.....	.....	.....	.....	.....	346,552	(1)
Colorado	.....	.....	.....	.....	.....	.....	729,516	(1)
Illinois	.....	.....	.....	.....	.....	.....	3,195,645	52,258,356
Indiana	.....	.....	.....	.....	.....	.....	7,533,290	122,527,774
Maryland	.....	.....	.....	.....	.....	.....	2,039,957	(1)
Massachusetts	.....	.....	.....	.....	.....	.....	891,400	(1)
Michigan	.....	.....	.....	.....	.....	.....	2,484,409	34,773,316
Minnesota	.....	.....	.....	.....	.....	.....	781,943	12,693,926
New Jersey	.....	.....	.....	.....	.....	.....	1,345,094	(1)
New York	.....	.....	.....	.....	.....	.....	5,164,790	69,074,052
Ohio	.....	.....	.....	.....	.....	.....	8,911,140	111,443,394
Pennsylvania	10,938	4,491,782	64.53	2,898,683	$36,367,550	$12.55	17,667,492	216,205,896
Tennessee	.....	.....	.....	.....	.....	.....	213,378	(1)
Texas	.....	.....	.....	.....	.....	.....	497,019	(1)
Utah	797	244,801	54.23	132,762	(1)	(1)	1,034,591	(1)
Virginia	750	263,983	59.78	157,812	2,300,193	14.58	157,812	2,300,193
West Virginia	982	276,686	64.01	177,108	2,535,415	14.32	3,359,965	36,906,180
Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin	195	77,243	62.90	48,583	(1)	(1)	2,122,039	(1)
Undistributed	.....	.....	.....	.....	2,742,469	15.12	.....	129,061,215
Total: 1949	13,662	5,354,495	63.78	3,414,948	43,945,627	12.87	63,637,429	842,737,696
1948	14,078	10,321,568	63.73	6,577,571	79,562,771	12.10	74,861,928	928,281,854

(1) Included with "Undistributed."

per cent of the annual coke production of the merchant and gas utility companies, and 2 per cent of the total United States annual coke capacity is expected to be lost because of the substitution of natural gas for coke-oven gas within the next 5 years. There is a possibility, however, that several of the larger plants now operated by gas utility companies may be sold to other interests, and that the coke plants will continue to operate.

In addition to the above, four coke-plant operators reported that one of the most important problems confronting them that will have a bearing on their con-

tinued operation is that of oven replacement. The coke ovens at such plants are fairly well depreciated, and although their remaining economic life is unknown, it is estimated that the ovens will be retired in less than 10 years. The companies in this category, having a total of 271 ovens with an annual coke capacity of 1,219,000 net tons, produced a total of 1,228,721 tons of coke in 1948, an amount slightly greater than capacity. The operators of these plants, where the economic life of the ovens appears to be limited, reported that they cannot justify the replacement of ovens because, even if mixed gas is distributed, the natural gas equivalent price of coke-oven gas does not compensate for the cost of producing coke-oven gas. It was pointed out, also, that under present economic conditions, difficulty is experienced in making limited repairs, because maintenance, rehabilitation, and construction costs are so high. It is possible, therefore, based on the reports received, that within the next 10 years a total of 592 coke ovens with a capacity of 2,547,200 net tons and a production in 1948 of 2,541,088 tons, may cease operations because of the substitution of natural gas for coke-oven gas. This group of ovens constituted 3 per cent of the oven-coke capacity, and they produced nearly 4 per cent of the total coke output in 1948.

In addition, several coke plants that produce pig iron for merchant sale only, as well as several merchant coke plants, stated that loss of their present city gas contracts may force them to curtail their current rate of coke and coal-chemicals production, but such an eventuality would not force closing the plants.

The ovens affected by the introduction of natural gas supply only a small amount of coke for blast furnace use, hence their closing is not expected to have any great effect on blast furnace operations; however, because the affected plants are widely scattered and in some instances located great distances from other sources of coke supply, a large number of iron foundries and small industrials purchasing coke from these plants will have a disruption of supply. The losses of chemical raw materials (crude tar, ammonia, and light oil), percentage-wise, from these plants are not large and under normal economic conditions should not have any great effect on the chemical industry. However, in times of emergency, the loss of coal chemicals from these plants could be more serious.

With the expansion of coke-making facilities in recent years, larger quantities of surplus coke-oven gas have been available from merchant companies and iron and steel producers. This has been purchased by gas utilities for distribution through city mains to residential, commercial, and industrial consumers. In 1948 there were 18 merchant coke plants active, of which 10 sold coke-oven gas to utilities. In addition, gas utilities purchased coke-oven gas from 23 oven-coke plants associated with the iron and steel industry.

SHUTTING DOWN COKE OVEN BATTERIES*

▲ THE Campbell Coke plant of the Youngstown Sheet and Tube Co. consists of six Koppers batteries of 51 ovens, each with a capacity of 500 cu ft.

When it is necessary to shut down a battery because of strikes, etc., we shut the battery down with the coke left in the ovens. Two hours before the last charge, the gas is cut off entirely from the flues with the air machines reversing. The oven doors are heavily luted, especially above the chuck door, and the charging lids are tamped and sealed to prevent infiltration of air to the coke in the oven.

When the gas in each oven becomes lean, the oven is dampered off from the collector main, the goose-neck cap is opened and the lean gas bled to the atmosphere. About five hours after the last charge, the cross-over closest to the exhausters is isolated and steamed out. Seven hours later the second cross-over is blanked off and steamed out.

Steam is now added to the collector main. Generally, 36 hours after the last charge, all ovens have stopped giving off gas and have been dampered off from the collector main and the goose-neck covers closed.

As each oven is dampered off, the liquor spray at this oven on the collector main is shut off. When the oven has stopped giving off gas, the liquor spray in the goose-neck is shut off and a slip blank inserted in the goose-neck at the collector main.

The day after a shut down all doors are sprayed with a mixture of fire clay and silica cement.

The gas is kept off the battery on an average of 36 hours, and the flue temperatures drop to an average of 1600 F.

After 36 hours, gas is put back on the battery with a gas pressure of 5 mm and a stack pressure of 8 mm.

The average flue temperatures for 34 days, with the coke in the battery, was 1640 F with a high in the center of the battery at 1860 F and end flues 1450 F.

With the coke pushed out of the oven, the average flue temperature for 22 days was 1580 F with a high in the center of 1625 F and end flues 1550 F showing more even temperature through the width of the oven.

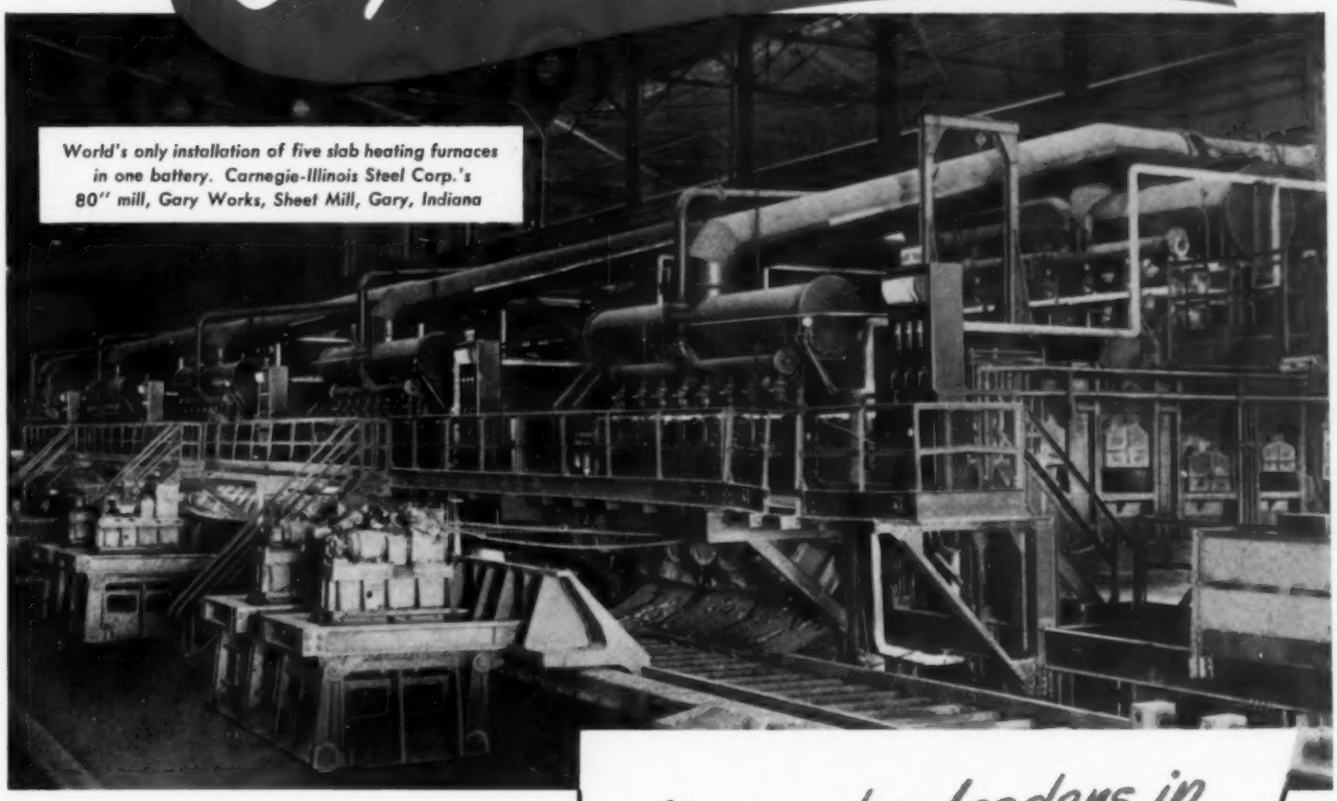
With the coke in the battery, we consumed an average of 684,000 cu ft of coke oven gas per battery per day. With the coke out of the battery we consumed an average of 1,440,000 cu ft of coke oven gas per battery per day.

The coke pushed after 36 days showed a loss of 78 tons from regular production from 51 ovens, all this being in furnace size coke. Analysis was practically the same with a drop in the stability test from 53.21 to 42.15 per cent on one inch screen. The blast furnace consumes this coke mixed with regular production coke.

Two days before charging a battery, all doors are taken off, the jambs sprayed and large holes are trowled. This is done in two eight hour turns with three patchers on a turn. A week after the battery is on operation the jambs are sprayed again.

*Abstracted from paper of same title presented by C. A. Covington, Supt. and A. H. Parthum, Asst. Supt., Campbell Coke Plant, Youngstown Sheet and Tube Co., at Pittsburgh Regional Technical Meeting of AISI, Oct. 11, 1950.

Only RUST has it *



World's only installation of five slab heating furnaces in one battery. Carnegie-Illinois Steel Corp.'s 80" mill, Gary Works, Sheet Mill, Gary, Indiana

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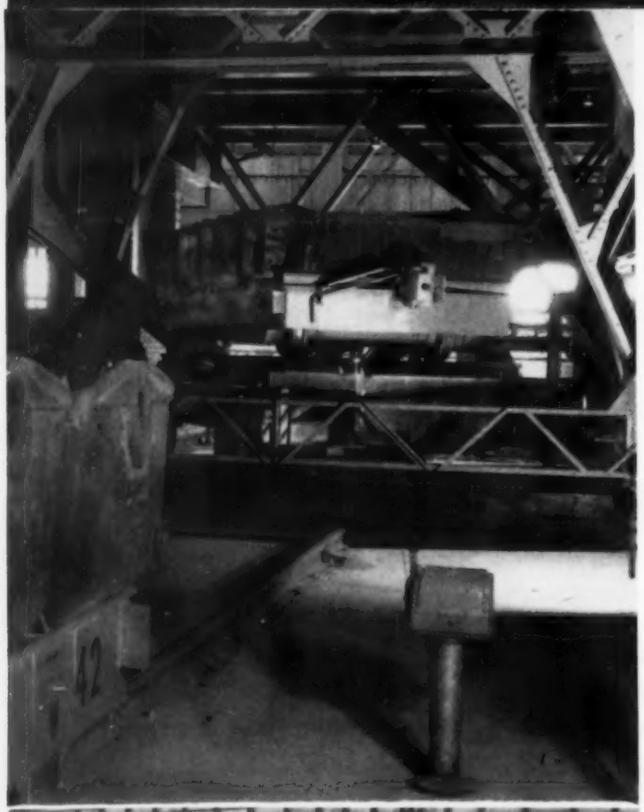
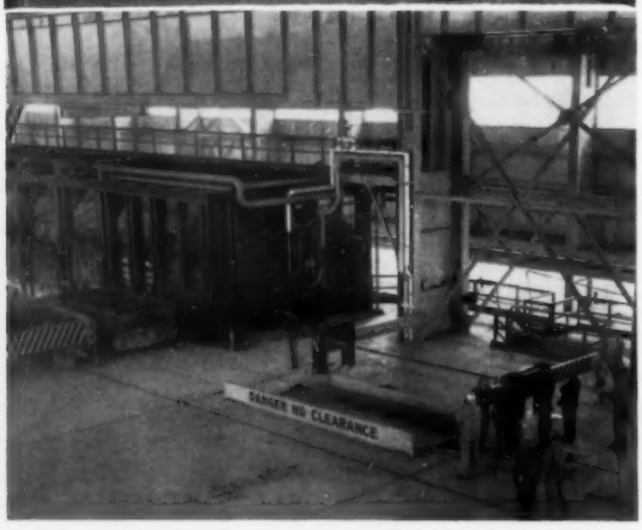
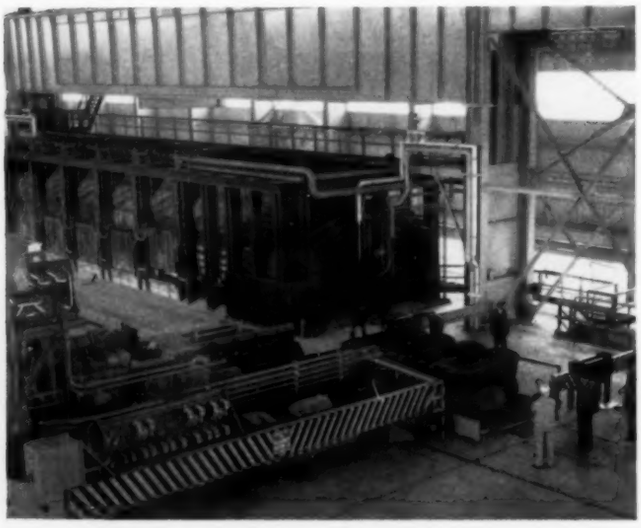


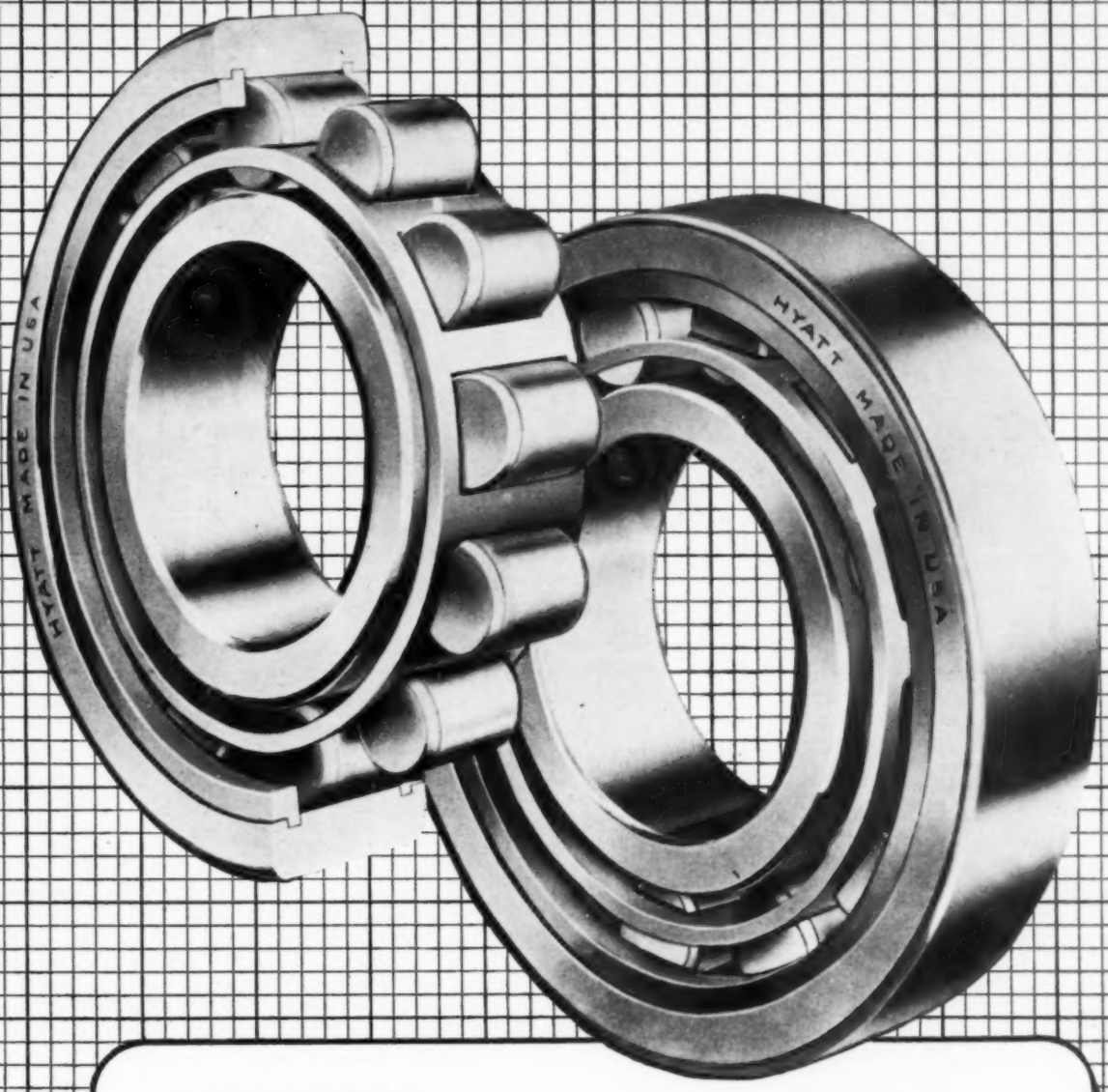
ARMCO OPENS OPEN HEARTH PLANT

▲ THE new open hearth plant at the East Works of Armco Steel Corp. (shown at top) incorporates some rather unusual charging features which are shown in the accompanying photographs. The charging pans are loaded and brought into the plant on the ground floor and (on left) the scrap buggy with pans is being elevated from the ground level to the open hearth floor. (On bottom left) is seen the top of the elevator on the charging floor. The charging machine is bringing the empty pans back to the hoist for lowering to the ground level. (On bottom right) the charging machine has brought the scrap buggy to the hydraulic lift which is now ready to return to the ground level.

At the time this plant was opened, Armco Steel Corp. announced a further expansion project whose estimated cost is $35,000,000.







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HYATT ROLLER BEARINGS

One Man Bull-Block Developed for Cold Draw

▲ One of the most recent developments in cold drawing was recently revealed at a demonstration at the Ellwood City plant of the Aetna Standard Engineering Co. Shown was a new unit completely equipped for drawing ferrous and non-ferrous tubes and rods.

One of the unusual features of this unit are that the push pointer and shears are an integral part of the unit. In all others, these two operations are separate. As a result the pointing and shearing is done continuously while the machine is in motion. Therefore, there is no stopping or starting until the cycle is completed. This feature results in more production since there is less time wasted in the actual drawing operation. A second outstanding feature is that only one man is required to operate the bull-block.

If drawing from coiled tubing, the operator places the coil in the pay-off; the end of the tube is then fitted over a conically shaped lubricating insert, with which the drawing lubricant is injected into the tube. If the operator is drawing from straight lengths, the end of the tube is merely advanced forward and the operator proceeds as above.

The floating pug is then inserted into the end of the tube, after which the tube is advanced through the shear (now in open position) into the push pointer. By means of push-button control, the push pointer is operated to grip the tube and force its end through the die. The end of the tube is thus advanced into the gripper jaws and the drawing operation is started by use of the "start" button to accelerate the block to preselected drawing speed. Near the end of the draw, the operator shears the trailing end of the tube by use of the crop shear which operates with the draw in progress.

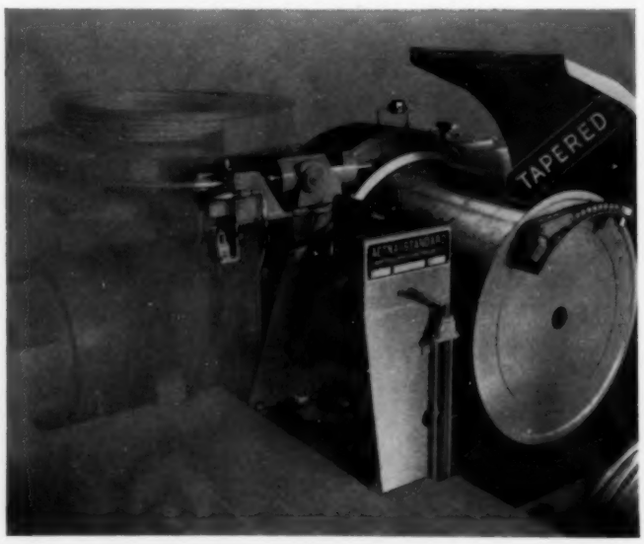
When the end of tube is pulled through the die, the block is stopped by dynamic braking of the main motor. The loose coil is then removed from the tapered drum and the operator is ready to prepare for the next coil. The coils in process are stored in a convenient manner between the pay-off and the coil unloading point. Normal procedure would involve running a large number of tubes through the first pass on the bull-block to storage. These tubes would then be in process; the next operation would be to run the entire lot through the second pass, etc.

The unit has a speed range from 150 to 660 fpm. The operator selects his speed by means of a manually operated rheostat. The unit is rated at 20,000 lb pull at 150 fpm and 6800 lb pull at 600 fpm.

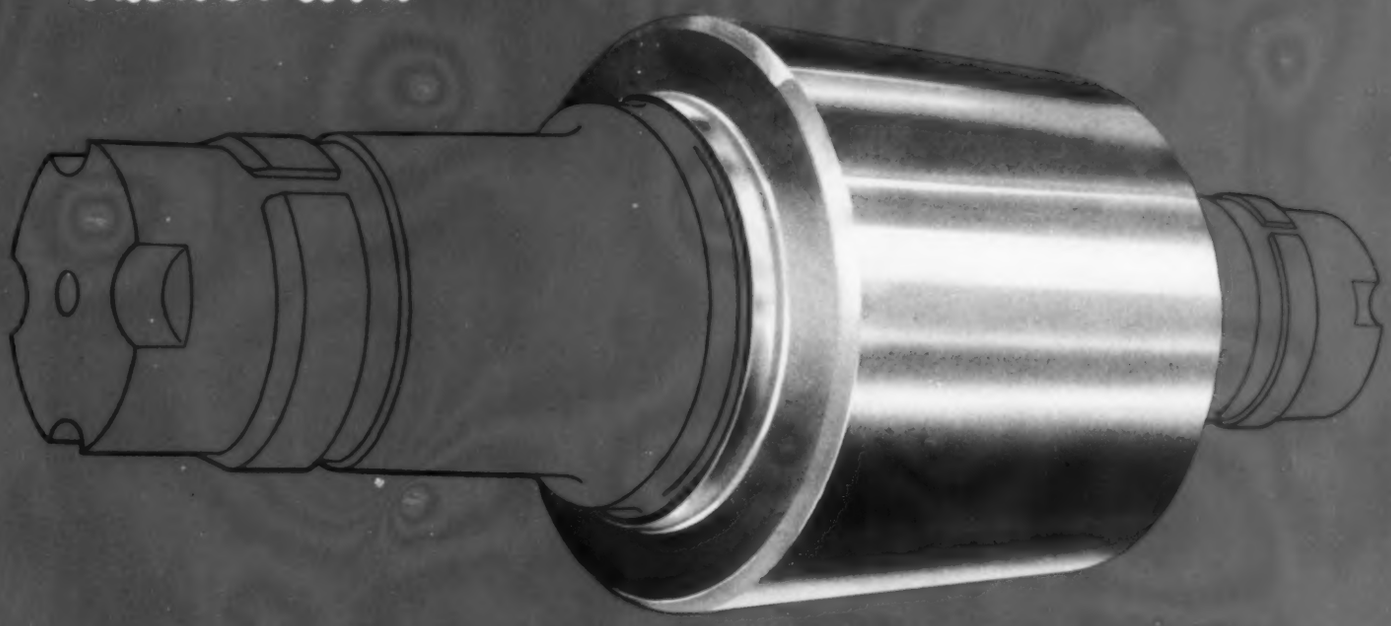
In a typical drawing cycle on copper tubing, a starting size of 1⅛ in. outside diameter × 0.070 in. wall would be finished in 5 passes to ⅜ in. outside diameter × 0.035 in. wall.

Figure 1 — Standard equipment for the unit includes crop shear and push pointer.

Figure 2 — To eliminate need of coil push-off, the bull-block is equipped with a tapered drum. When draw is complete, the tapered design enables operator to unload coil with ease.

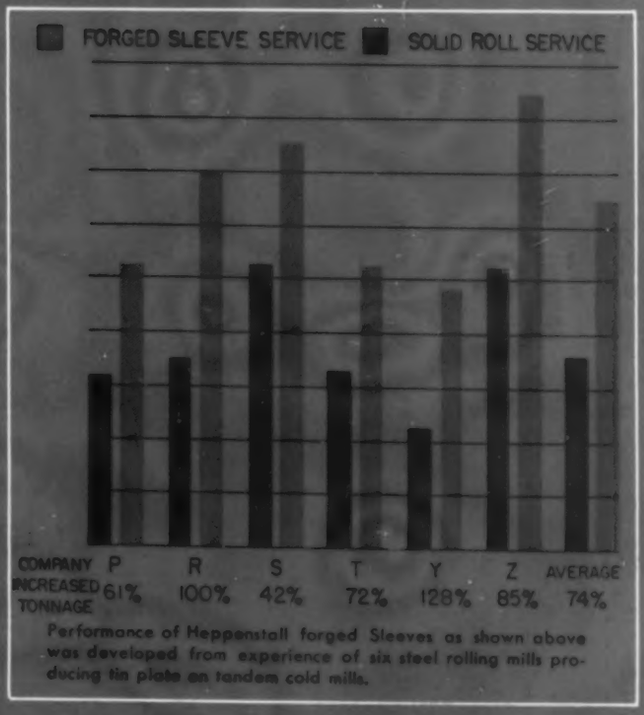


- *for increased tonnage*
- *longer roll life*
- *lower costs*



• Heppenstall back-up roll Sleeves

Correct hardness . . . maximum density . . . perfect fit—that's the story behind the *74% average tonnage increase* obtained with Heppenstall Sleeves. Working surfaces last longer—resist cracking and spalling in high speed service because each Heppenstall Sleeve is forged from our own alloy steel and "custom-built" . . . normalized, annealed, heat treated and tempered to exact specifications. Use Heppenstall forged Sleeves on your back-up rolls and prove their superior performance under your own operating conditions. Remember, too, that Heppenstall produces forged arbors . . . grinds arbors and sleeves for perfect shrink-fitting . . . has complete facilities for turning down your worn rolls for resleeving. And for maximum economy, arbors may be resleeved several times before scrapping. Heppenstall Company, Pittsburgh 1, Pa.



Performance of Heppenstall forged Sleeves as shown above was developed from experience of six steel rolling mills producing tin plate on tandem cold mills.

Heppenstall

—the most dependable name in forgings

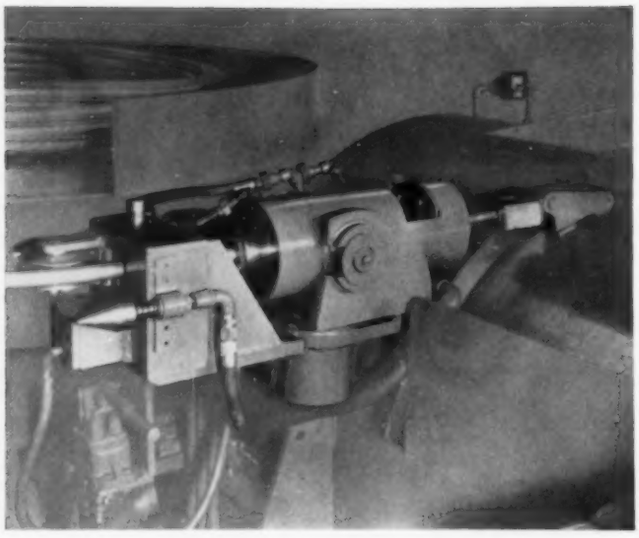


Figure 3 — Shear cuts off trailing end of tube during drawing operation without stopping block. Hydraulic push pointer with integral die box points tubing just prior to drawing. Use of push pointer and shear eliminates manual handling of coil between draws.

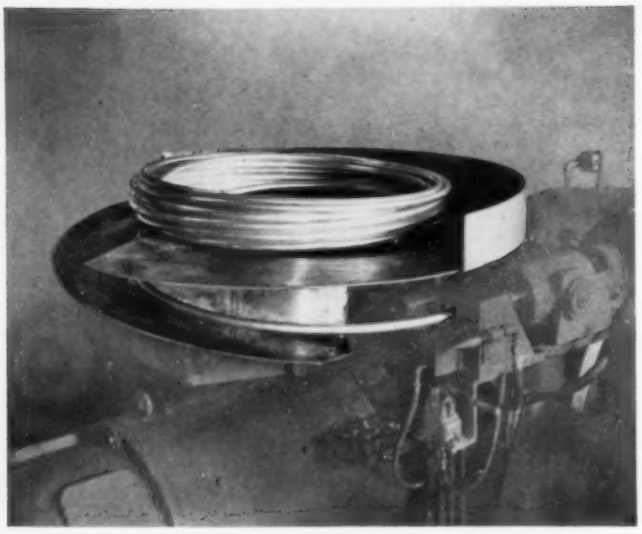


Figure 4 — To facilitate handling of tubing at the entry end, the machine is equipped with a coil pay-off of special design. The unit is integral with the bull-block.

The maximum size copper tube drawn to date is $1\frac{3}{8}$ in. outside diameter $\times$ 0.090 in. wall. The drum is 48 in. in diameter and has a 40-in. face. It is designed to accommodate up to a 54-in. diameter drum. A special coil pay-off which is integral with the bull-block as well as the tapered drum provides easy removal of the coil. Auxiliary equipment included in the unit consists of a hydraulic push pointer for pointing tubes, a crop shear for cutting off the trailing end of the tube without stopping the block. Pointer and shear are integral with die block. A lubricating unit for internal and external lubricating of the tube and a hydraulically movable guard for the gun.

The unit can be made available in other ratings to suit requirements.

PRODUCTION OF LIGHT WEIGHT AGGREGATE FROM BLAST FURNACE SLAG

▲ In recent years much research has been carried on, looking to the development of an aggregate for use in the manufacture of concrete blocks, pre-cast roof slabs, and other masonry products.

The ideal aggregate would have five major characteristics, namely, light weight, compressive strength, proper size graduation, sufficiently dry for economical transportation and efficient mixing, and free of objectionable coloration. The expanded, or granulated slag aggregates made by the Kinney-Osborne Process meet these ideal qualities.

Basically, the process consists of the use of a combination of steam, air and water, steam and air for the motive force and steam and water for contracting and expanding the slag. No machine is used and there are no mechanical parts to wear. In this process the slag is treated at the cinder runner direct from the monkey, (or slag ladle).

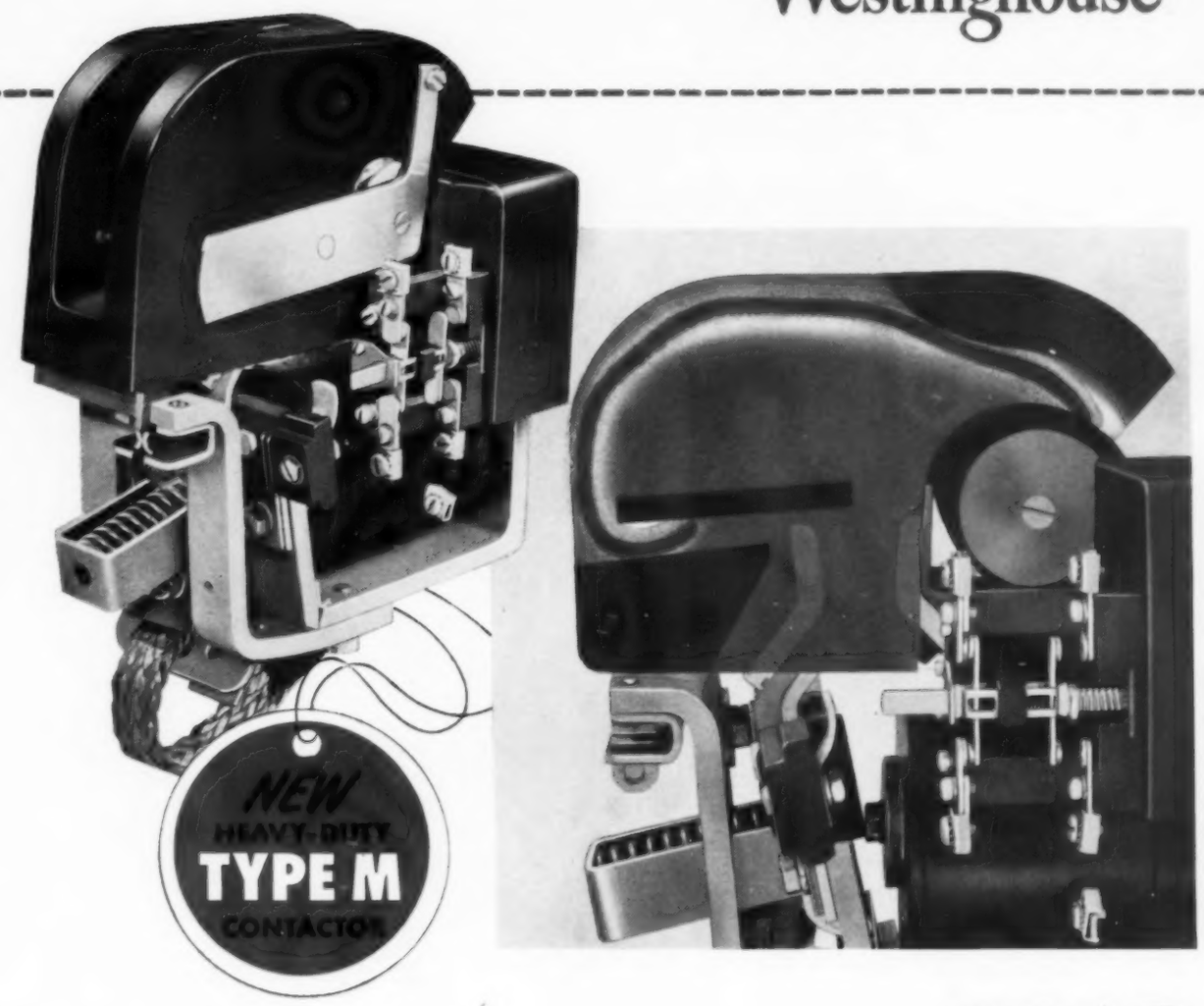
The granulating is accomplished at the end of the cinder runner as the slag enters a chute connected to an opening near the top of a small blow chamber. In the chute, a blast of steam and air and sometimes a small amount of water breaks up the slag into numerous small globules. These globules immediately encounter water in the form of a very fine spray, or mist, from a number of nozzles located in a semi-circle around the chute. The fine atomized water spray contacts all of the relatively large surface area of the small globules and completes the expansion action. There is usually a large nozzle, the use of which is not required with certain slags. This nozzle can be supplied with steam and low pressure air as water.

As the slag is blown through the air into the blow chamber, it falls to the floor, and there is a reagglomeration of the hot, but already expanded product. By the use of a conveyor the expended slag can be transported through a crusher and onto screens. The slag passing through the screen falls directly into cars ready for shipment. The slag not passing through the screen can be recycled back through the crushers. The slag is being air cooled while this process is going on.

The ease of control along with the wide choice of mixtures for granulating (air, steam and water), makes this process adaptable to the wide range in composition and temperature of furnace slag. The multiplicity of nozzles, individually controlled, and with the use of water, steam and/or high and low pressure air, the force and amount of which can be varied at will, provide a method for changing conditions instantaneously to adapt them to the chemical and physical properties of the slag being produced at the time.

In addition to the advantage of low initial cost, maintenance costs are low. This is due to the fact that the slag has no contact with moving equipment prior to preliminary cooling.

YOU CAN BE SURE.. IF IT'S
Westinghouse



HOT ARCS STOPPED COLD!

When a d-c contactor opens under load, hot arcs leap between opening contacts. Burning with terrific heat, arcs bead and pit contact area—unless they are controlled and extinguished *quick*.

Arcs don't have a chance in the Westinghouse D-C Type M Contactor. In half a wink—less time than it takes contacts to open fully—the exclusive double-pocket, "Qwik-Quench" arc box with special side-plate design increases blowout flux density across the contacts . . . speeds the arc to the arc horns . . . and extinguishes it. Action is *fast*.

Result? Contacts stay clean . . . need less service . . . last longer . . . stand up to millions of make-breaks under heavy loads. Arc boxes last longer.

Fast arc quenching is but one feature of new Type M Contactor. Ask your Westinghouse representative to tell you about the unit construction . . . the self-cleaning knife-edge bearing . . . the unit-mounted interlocks, and other exclusive Type M features.

Call him today for a copy of B-5261 and the complete Type M story. Or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna.

J-27001

Westinghouse
STEEL MILL
MOTORS AND CONTROLS

With rare exceptions on commercial and industrial installations

Ordinary Fuses and Breakers Do Not Protect Except Against Short-Circuits But—

Fusetron DUAL-ELEMENT Fuses

Provide 10 Point Protection

What is the FUSETRON Dual-Element FUSE?

A fuse link combined with a thermal cutout — the result, a fuse with tremendous time-lag and much less electrical resistance.

They have the same degree of Underwriters' Laboratories approval for both motor-running and circuit protection as the most expensive devices made.

Made to the same dimensions as ordinary fuses, FUSETRON Fuses fit all standard fuse holders.

Obtainable in all sizes from 1/10 to 600 ampere, both 250 and 600 volt types. Also in plug types for 125 volt circuits.

Their cost is surprisingly low.

(FUSETRON is a trade mark of the Bussmann Mfg. Co., Division of McGraw Electric Co.)

Count 'em

1* Protect against short-circuits.

2 Protect against needless blows caused by harmless overloads.

3 Protect against needless blows caused by excessive heating — lesser resistance results in much cooler operation.

4 Provide thermal protection — for panels and switches against damage from heating due to poor contact.

5 Protect motors against burnout from overloading.

6 Protect motors against burnout due to single phasing.

7 Give DOUBLE burnout protection to large motors — without extra cost.

8 Make protection of small motors simple and inexpensive.

9 Protect against waste of space and money — permit use of proper size switches and panels.

10 Protect coils, transformers and solenoids against burnout.

★ Fusetron Fuses have high interrupting capacity as shown by tests of the Electrical Testing Laboratories of New York City in December 1947.

FUSETRON

TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION

BUSS

DON'T RISK LOSSES

One **needless** shutdown — one **lost** motor — one **destroyed** switch or panel — one **burned out** solenoid — may cost you **far more** than replacing every ordinary fuse with a FUSETRON dual-element fuse.

Mail the coupon now for complete information about the All-Purpose Protection of FUSETRON Dual-Element FUSES.

Bussmann Mfg. Co., University at Jefferson
St. Louis 7, Mo. (Division McGraw Electric Co.)

Please send me complete facts about FUSETRON Dual-Element FUSES.

*Name*_____

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There is a LINK-BELT Ball or Roller Bearing For Every Purpose

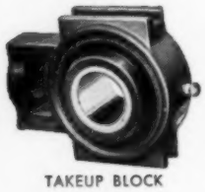
- **for light or heavy loads** in capacities to hundreds of thousands of pounds.
- **for low speeds or high speeds** to 5000 revolutions per minute, rated speeds. Higher speeds upon consultation.
- **for grease or oil lubrication** solid housing blocks for grease lubrication. Split housing blocks for either grease or oil.
- **for fixed or floating mounting** fixed housings for shaft location, floating bearings to provide for expansion and contraction.
- **for small or large shafts** in diameters from ⅝ to 7½ inches.
- **locked-on or pressed-fit** to suit commercial shafting or precision finished shafting.
- **with closed or open end** closed end for extra protection, open end for through shaft.
- **with solid or split housing** solid housing blocks for simplicity, split housing blocks for ease of installation.

FLANGED BLOCK

FLANGED CARTRIDGE BLOCK

HANGER BLOCK

CARTRIDGE BLOCK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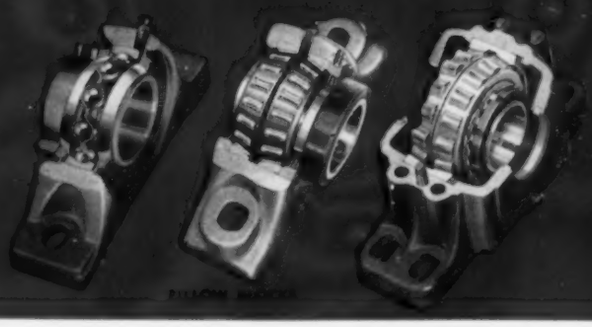
UNMOUNTED BEARING

May we send you the new Link-Belt Ball and Roller Bearing Catalog No. 2550, showing the complete line? A LINK-BELT engineer will make unbiased recommendations.

THE SYMBOL OF QUALITY LB LINK-BELT

LINK-BELT COMPANY Indianapolis 6, Chicago 9, Philadelphia 40, Atlanta, Minneapolis 5, Houston 1, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Johannesburg. Offices, Factory Branch Stocks and Distributors in Principal Cities. 11,003

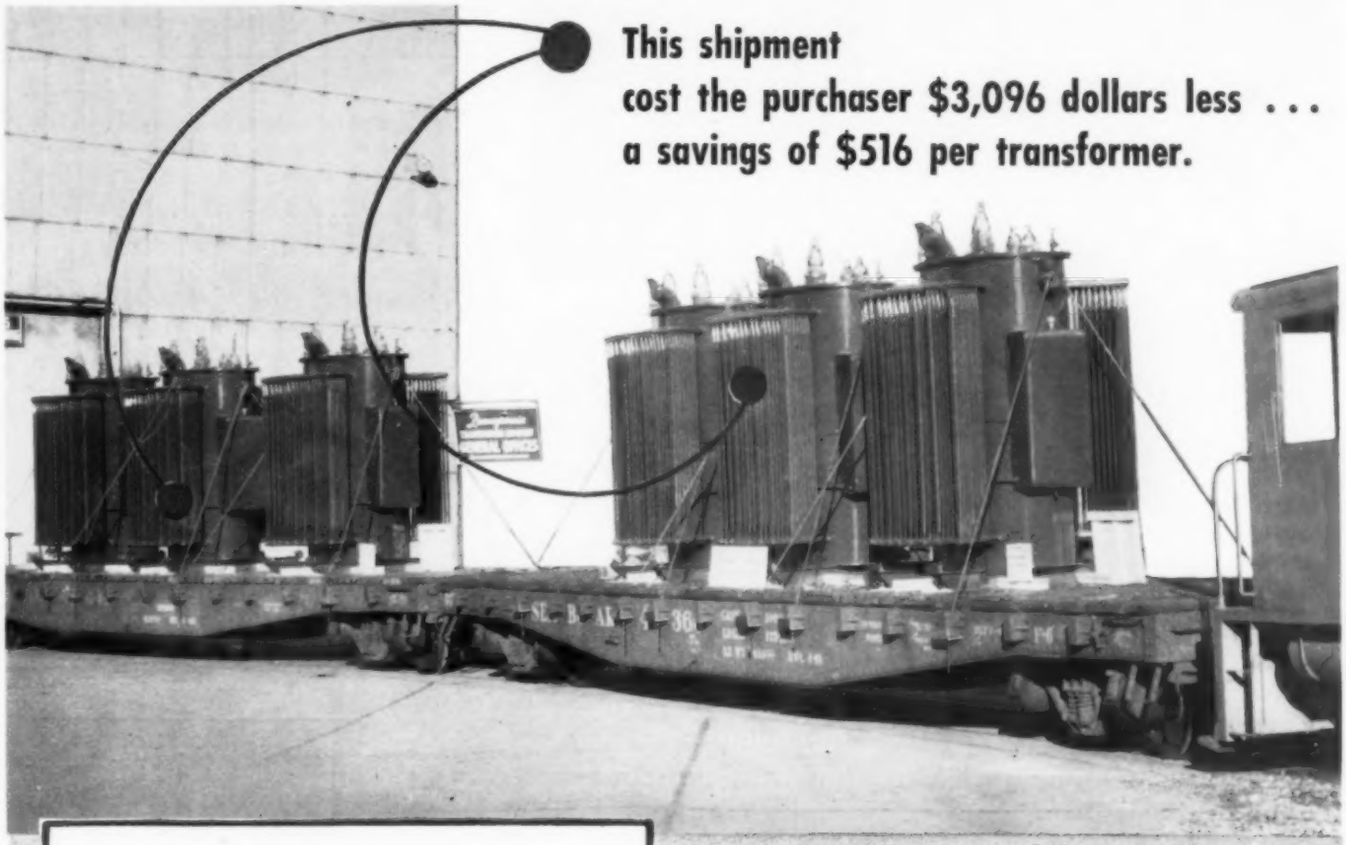
A complete line of bearings is available from stock, throughout the country, in pillow blocks, cartridge, flanged cartridge, flanged, hanger and take-up blocks —also unmounted bearings.



LINK-BELT

BALL & ROLLER BEARINGS

You pay LESS for Pennsylvania Standard Parts Power Transformers



This shipment cost the purchaser $3,096 dollars less . . . a savings of $516 per transformer.

6-2,000 Kva, 1 phase, 60 C., 55° C., OA, OUTDOOR, — H. V. : 13,800 Volts.
Full capacity taps for 14,400, 14,100, 13,500, and 13,200 volts. — L. V. : 2400 4160Y Volts.
Inert gas — oil seal.

WHY

Standard Parts Power Transformers Can Be Sold For Less

Standard Parts Power Transformers can be purchased at worthwhile savings because of quantity production of standard parts produced with adequate tools and equipment. This has improved the quality of the workmanship, reduced the possibility of errors, and permitted more rigid inspection during the various stages of production. These factors, together with reduced production time, have shown a cost saving which has been passed on to the user.

A considerable amount of money was saved in the purchase of these transformers because the purchaser's requirements — mechanical and electrical — fitted into Pennsylvania's Standard Parts Power Transformer program.

Standard Parts Power Transformers are single phase transformers in sizes up to 5,000 Kva, 69 Kv; and three phase transformers in sizes up to 10,000 Kva, 69 Kv, which have standard or optional voltage ratings and standard or optional accessories. The type of oil preservation method familiar to the purchaser's operating personnel is supplied on these transformers — gas-oil seal, sealed tank, inert gas pressure, or expansion tank system.

Pennsylvania TRANSFORMERS

Pennsylvania TRANSFORMER COMPANY

Canonsburg, Pennsylvania — Greater Pittsburgh District

Trabon

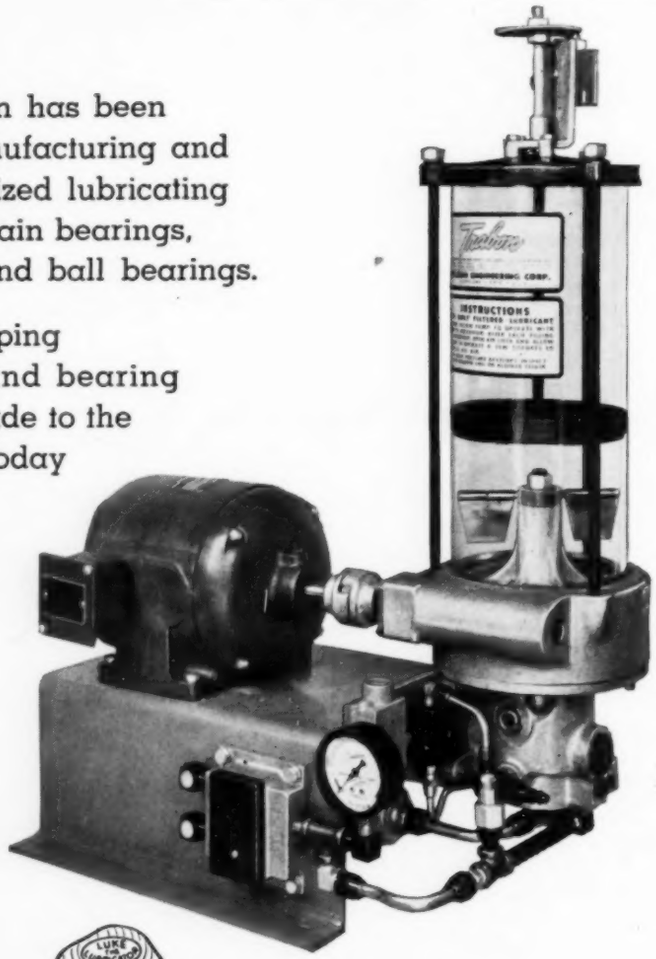
DELIVERS A MEASURED AMOUNT OF LUBRICANT....

- *To Any Bearing...*
- *In Any Location...*
- *Under Any Condition!*

Since 1930 Trabon has been engineering, manufacturing and installing centralized lubricating systems . . . for plain bearings, roller bearings and ball bearings.

Since 1922 Trabon has been helping industry solve its lubricating and bearing problems. Progress has been made to the point where Trabon systems of today are almost human. The Trabon lubricating system is made part of the machine.

Call in a Trabon man today. He has the solution to your lubricating problem.



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IT'S FULLY HYDRAULIC!"

Trabon

OIL AND GREASE SYSTEMS

TRABON ENGINEERING CORPORATION
1814 East 40th Street • Cleveland 3, Ohio

Date-line Diary...

October 1

▲ Secretary Sawyer of the Commerce Department announced that the steel industry plans to increase plant capacity by 9,400,000 tons to a 109,963,000 tons by the end of 1952. Blast furnace capacity will be increased 1,734,000 tons to 73,378,000 tons.

October 2

▲ The Bureau of Labor Statistics and the Commerce Department report that construction put in place in September set a new record at $2,800,000,000.

▲ Commerce Department reported that cash dividends paid in August were $212,900,000, 11 per cent over a year ago.

▲ Based on reports from companies having 94 per cent of the steel capacity of the industry, the operating rate is scheduled at 101.2 per cent of capacity for the week beginning October 2, 1950. This is equivalent to 1,951,900 tons compared with 1,942,200 tons one week ago.

October 3

▲ The National Production Authority set up a priority system and thus initiated the DO order.

▲ CIO officials said that wage increases of undisclosed amount but over 15¢ an hr will be asked of the basic steel producers.

▲ The NPA will start steel allocations for freight car builders sufficient in magnitude to enable construction of 8000 to 12,000 freight cars per month.

▲ The Engineering News Record reports that engineering construction in the first nine months of 1950 rose to a new high of $8,964,000,000, and higher than any previous year.

October 4

▲ Henry Roemer, president Sharon Steel Corp. announced that his company is considering a 5 year $49,000,000 expansion program, which will add 550,000 tons to firm's present capacity of 1,440,000 tons.

▲ Construction contracts for the 360 mile railroad from the Quebec-Labrador ore fields to Seven Islands on the St. Lawrence River were let. Cost will be over $100,000,000.

▲ Pennsylvania Railroad ordered 5000 additional freight cars at a cost of $30,000,000.

October 5

▲ Phillip Murray plans to ask for an increase in the spread between the 32 job classifications which will change the present differential from 4½ to 5¢.

▲ Association of American Railroads reported that net rail income for the first eight months of 1950 was $336,000,000 compared with $242,000,000 in 1949.

▲ Freight car orders in September totaled 25,611. Production totaled 5131 leaving a total backlog on October 1 of 106,611.

October 7

▲ Columbia Transportation Co. placed orders for two Great Lakes ore carriers which will each have a capacity of 19,500 tons at a cost of $5,000,000 each.

October 8

▲ American Iron and Steel Institute reports that the payroll for August was $206,623,000 or $500,000 under the record March 1949. Hourly wages averaged $1.717 in August for an average 39.7 hr a week. Average employment was 648,900.

▲ Shipments of steel products in August set a new monthly record of 6,326,500 net tons according to the AISI.

October 9

▲ Based on reports of companies having 94 per cent of the steel capacity of the industry, the operating rate for the week beginning October 9th is scheduled at 101.6 per cent of capacity. This is equivalent to 1,959,600 tons compared with 1,951,900 tons one week ago.

October 10

▲ The British Labor Government announced that it will take over the British iron and steel industry on February 15, 1951.

October 11

▲ The Lake Carriers Association reports that iron ore moved on the Great Lakes in September totaled 12,190,669 gross tons. Total movement for the year to October 1 totaled 58,959,639 gross tons.

October 12

▲ The H. K. Porter Co. purchased the Connors Steel Co. of Birmingham, Ala.

October 13

▲ Commerce Department reports that total imports in the United States in August set a new high of $819,000,000. Exports dropped to $761,000,000 leaving an import surplus of $58,000,000 the first such surplus since June 1937.

▲ The NPA issued a directive which limits the amount of DO orders each steel company will have to accept.

October 14

▲ The Federal Reserve Board tightened installment buying curbs. Times of loan were shortened and down payments were increased on certain items.

▲ Assistant Secretary of the Interior Davidson stated that steel industry plans for expanding capacity are inadequate. He feels that by 1953 the country needs a capacity of 125 to 130,000,000 tons.

▲ Ward's automotive reports predicted automobile production in 1950 will reach a new high of 6,600,000 units. Most companies have sufficient steel to continue full operations during the rest of the year with perhaps two exceptions.

October 15

▲ The F. W. Dodge Corp. reports that construction contracts awarded in September in the 37 states east of the Rockies totaled $1,286,541,000 and down 17 per cent from August but 18 per cent higher than one year ago.

▲ Vanadium Corp. of America plans to spend $4,000,000 to expand and modernize its Niagara Falls, N. Y. plant.

October 16

▲ The Pittsburgh office of the Pennsylvania State Employment Service reported that steel plants have had to raise their hiring age limits from 35 to as high as 50 in order to get manpower.

▲ Based on reports of companies having 94 per cent steel capacity of the industry the operating rate beginning October 16th is scheduled at 102.0 per cent of capacity. This is equivalent to 1,967,300 tons compared with 1,959,600 tons one week ago.

▲ Labor Department reports that non-farm employment in mid-September reached a new high with 45,500,000 persons in non-farm work.

▲ The Bureau of Mines reports that shipments of iron ore from domestic mines in August exceeded 15,000,000 gross tons for the first time since 1943. Production was 14,477,706 tons and shipments were 15,012,167 tons.

October 17

▲ Keystone Steel and Wire Co. announced that it will construct a fourth open hearth at Peoria, Ill., which will increase ingot capacity 100,000 tons. Estimated cost is $1,500,000.

▲ Armco Steel Corp. is embarking on a $35,000,000 expansion program at the East Works at Middletown, Ohio. Included is a 1500-ton blast furnace and 75 by-product ovens. A large electric furnace will also be constructed at Houston, Tex. for the Sheffield Steel Corp. subsidiary.

October 18

▲ Price of spot tin rose in New York to $1.12½ a lb.

▲ Youngstown Sheet & Tube Co. appropriated $9,000,000 for expansion and modernization of plants in the Youngstown area.

▲ Brainard Steel Co. is leasing from the government a $7,000,000 plant at Warren, Ohio.

▲ Bethlehem raised pig iron prices $3.00 a ton resulting in new price for basic pig of $51.00.

October 19

▲ The AISI reports that imports of critical manganese, chromium and tungsten in the first half of 1950 were ahead of 1949.

October 20

▲ The AISI reports that over 4,200,000 tons of titanium were used in American steel manufacture in 1949.

▲ Allegheny Ludlum Steel Corp. established new sales, earning and employment records in the third quarter of 1950. Third quarter sales were $46,012,223 and earnings were equivalent to $2.14 a share.

▲ Republic Steel Corp. sold its holdings of common stock in the Cleveland Cliffs Iron Co.

▲ Price of spot tin rose in New York to $1.13½ a lb.

October 21

▲ The NPA set aside for defense needs all steel alloys containing columbium.

▲ National Tube Co. announced that because of the increase in the price of zinc, prices of galvanized pipe had been increased an average of $3.80 a ton.

October 23

▲ Based on reports from companies having 94 per cent capacity of the industry, the operating rate of the steel industry is scheduled at 102.6 per cent of capacity for the week beginning October 23rd. This is equivalent to 1,978,900 tons compared with 1,967,300 tons one week ago.

October 24

▲ Lake Superior Iron Ore Association reports that consumption of Lake Superior iron ore in September amounted to 7,474,745 gross tons. This brings total used for first nine months to 61,971,360 tons compared with 59,805,792 tons in corresponding period of 1949.

October 25

▲ Inland Steel Corp. reports that third quarter sales set a new record of $122,550,102 up 32.8 per cent from 1949. Net income was $12,082,908 or $2.47 a share compared with $1.55 a share in 1949.

▲ Youngstown Sheet and Tube Co. declared a quarterly dividend of 75¢ a share and an extra dividend of 25¢ a share payable December 15th.

▲ Three steel companies, Republic, Youngstown Sheet and Tube and Wheeling reported that they had to cut back on production of galvanized products because of zinc shortages.

October 26

▲ AISC reports that bookings of fabricated steel in September were 249,315 tons and shipments were 155,960 tons. Backlog for the next four months totaled 716,393 tons compared with 562,211 tons one year ago.

▲ Aluminum Association reports that shipments of aluminum sheet and plate in August totaled 113,531,771 lb compared with 90,937,020 lb in July. A total of 126,011,903 lb of primary metal was produced in August.

▲ The Edison Electric Institute reports that the electric power supply is sufficient for civilian and military needs. A survey estimates that total generating capacity is about 12 per cent in excess of the maximum demand of 7,500,000 kw.

▲ Drilling crews of the Bethlehem Steel Co. are to continue drilling operations through the winter at Marmora in Eastern, Ontario. It is believed that ore deposits exist in this area.

▲ Republic, Bethlehem, Youngstown Sheet & Tube and Kaiser reported an average rise of $3.80 to $4.00 a ton for galvanized pipe due to the increased cost of zinc.

October 27

▲ A strike was called by 750 blast furnace workers at the Lackawanna Plant of the Bethlehem Steel Co.

▲ Bethlehem Steel Corp. reported third quarter earnings at $33,563,841 or $3.33 a share compared with $2.23 a share in 1949. A $2.00 dividend was declared. Total billings for the second quarter were $370,534,500.

October 28

▲ The NSRB is planning to use extensively the accelerated depreciation provisions of the 1950 tax law to spur expansion of productive facilities.

▲ The Lone Star Steel Co. started operation at its new $1,500,000 cast iron pipe foundry.

▲ H. K. Porter Co. plans to spend $500,000 in expanding production facilities at Connors Steel.

October 29

▲ The API announced that the petroleum industry will spend $2,400,000,000 this year for oil exploration and modernizing and expanding oil production facilities.

October 30

▲ Armco Steel Corp. reports earnings in the third quarter of $12,037,343 or $3.03 a share compared with $1.63 a share for the same period one year ago.

▲ The operating rate of the steel industry for the week beginning October 30 is scheduled at 102.4 per cent of capacity. This is equivalent to 1,975,000 tons compared with 1,978,900 tons one week ago.

October 31

▲ National Steel Corp. reports net earnings for the third quarter of $14,042,525 or $1.91 a share and comparable with $1.36 a share for the same period in 1949.

▲ Jones & Laughlin Steel Corp. announced net income for the third quarter of $11,233,078 or $4.18 a share compared with $1.73 a share one year ago. A dividend of $1.25 a share was declared on the 5 per cent cumulative preferred stock and a cash dividend of 80¢ on the common stock.

▲ United States Steel Corp. reports that third quarter earnings were $59,742,302. A dividend of 75¢ a share was declared on the common as well as a special dividend of 75¢ a share.

▲ The Granite City Steel Co. started to cut back galvanized sheet production one-third because of the scarcity of zinc.

▲ Price of lead rose to 17¢ a lb in New York.

▲ Henry J. Kaiser paid the RFC $91,185,990.80 in full payment of the loans on the Fontana plant. This payment resulted from the successful completion of the $125,000,000 financing program. Kaiser paid $1.23 for each dollar borrowed when interest was taken into account. Remainder of financing program will be used for plant expansion and working capital.

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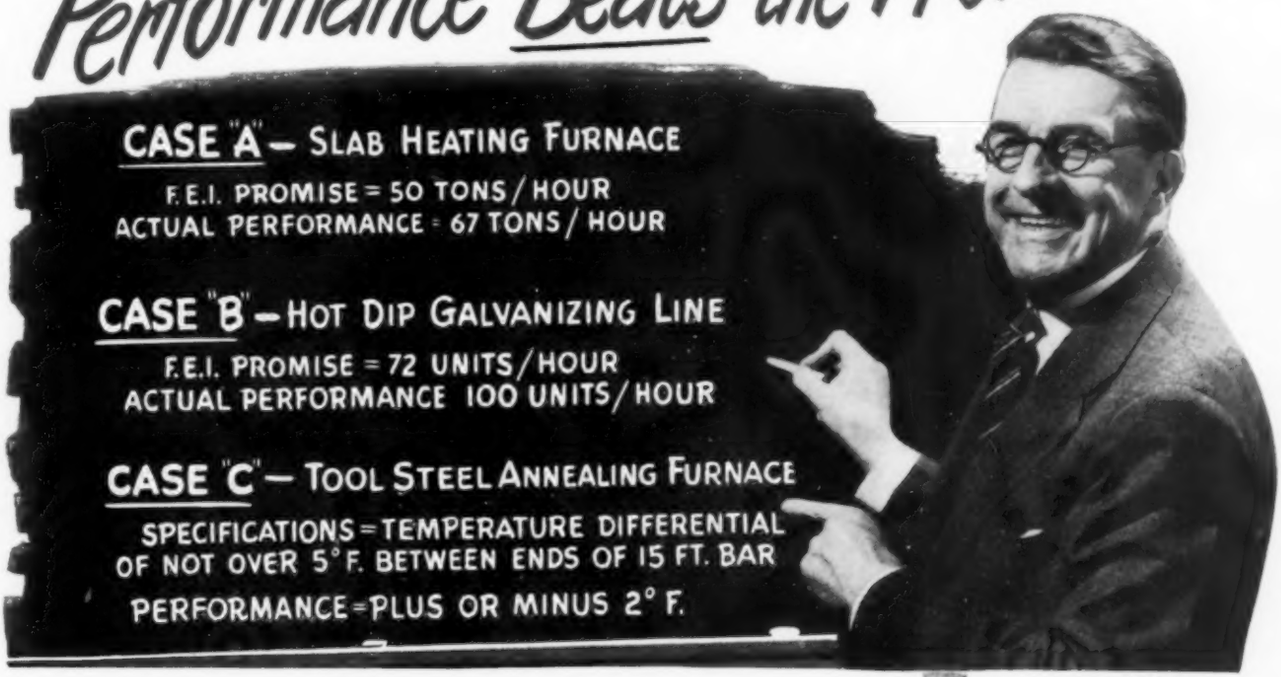
Performance Beats the Promise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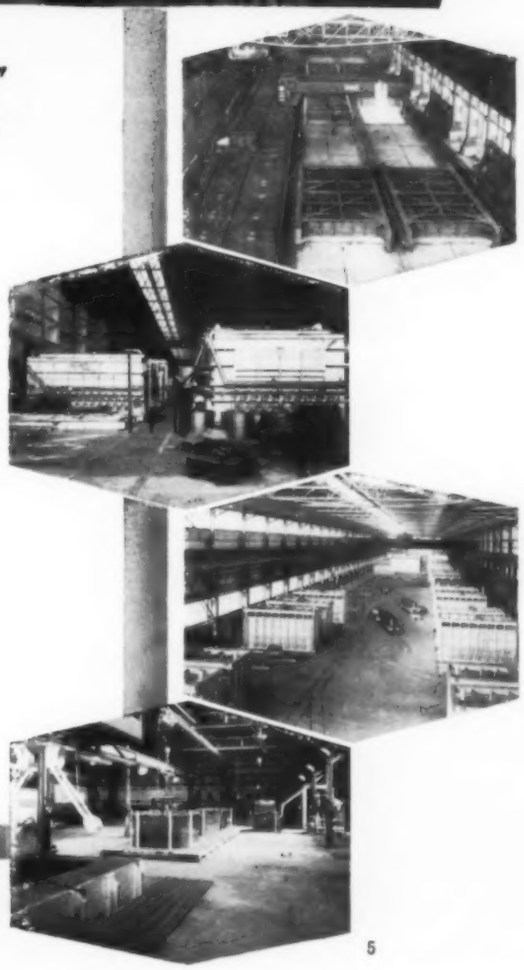

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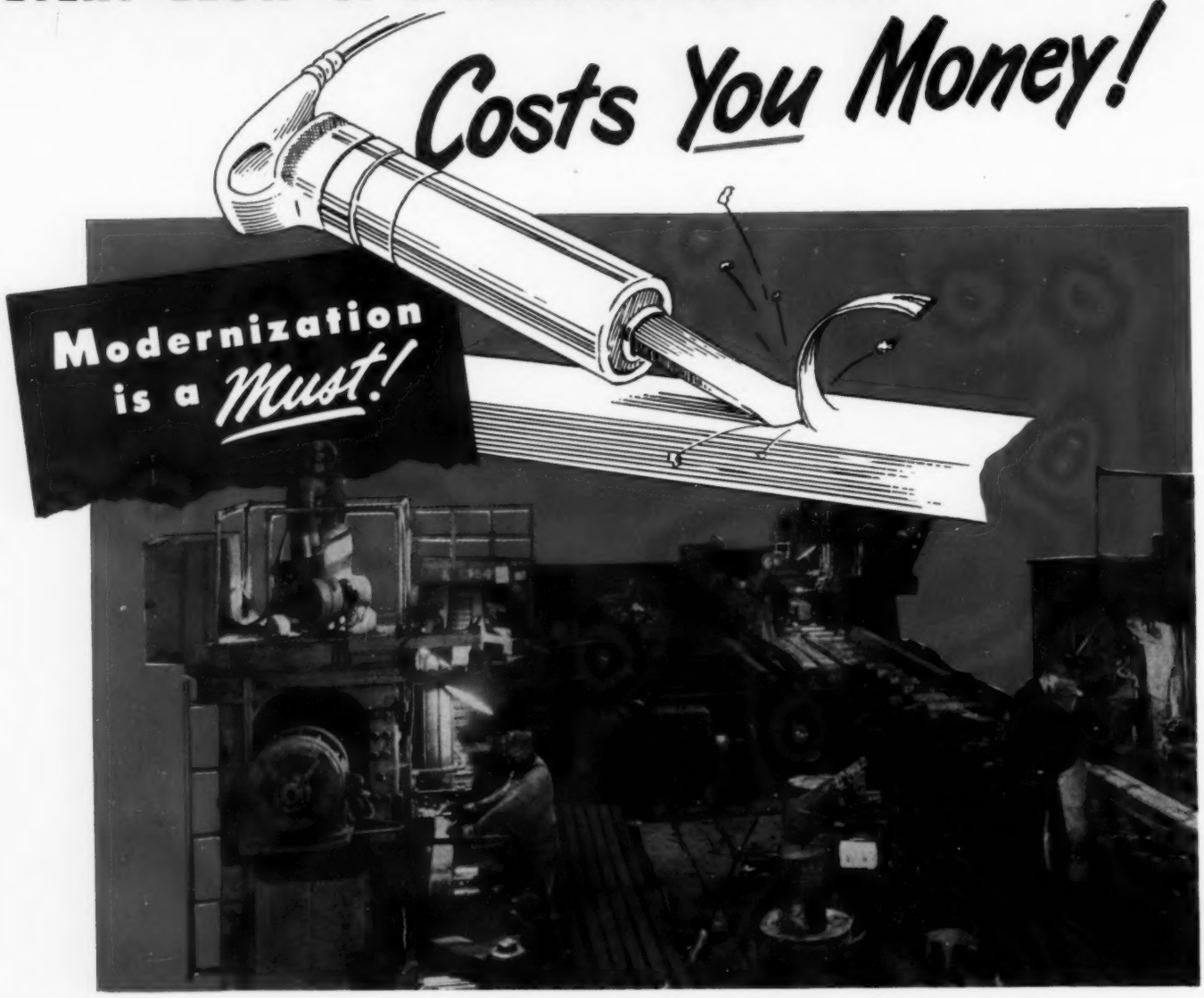

If billet conditioning still is done by hand in your mill, you can *save money, time and man-power* with a Bonnot Billeteer. These modern high-precision machines insure a dependable flow of clean billets ready for rolling — completely eliminating all the inherent problems of manual billet conditioning.

See for yourself why Billeteers are a "must" for a "war or peace economy" by comparing all-out Billeteer performance with grueling, dangerous hand methods of cleaning:

BONNOT BILLETEERS —

- cut costs 56%
- reduce employee turnover in billet sheds
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If you, too, would like to *eliminate man-power problems and excessive costs* in your billet sheds with Bonnot Billeteers, call or write today for complete information!

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Industry News...

U. S. STEEL CORP. MERGES FOUR SUBSIDIARIES INTO NEW FIRM: U. S. STEEL COMPANY

▲ Irving S. Olds, chairman of the board of directors of United States Steel Corp., made the following statement on November 7:

"For the purpose of bringing about a simplification of the corporate structure of United States Steel, a program has been adopted to bring together into a single operating company, as of January 1, 1951, four wholly-owned subsidiaries of United States Steel Corp., namely: United States Steel Corp. of Delaware, Carnegie-Illinois Steel Corp., H. C. Frick Coke Co., and United States Coal and Coke Co.

"This single company will also be a wholly-owned subsidiary of the corporation and will be called United States Steel Co. Its headquarters will be in the new office building now being erected for United States Steel and others in Pittsburgh, Pa.

"Benjamin F. Fairless, who is now president of United States Steel Corp. of Delaware, will become president of this single company. He will continue as president of the parent company, United States Steel Corp. The other principal executives of this single operating company will consist of five executive vice presidents: Clifford F. Hood—operations; David F. Austin—commercial; Roger M. Blough—law and secretarial; Malcolm W. Reed—engineering; George W. Rooney—accounting.

"Mr. Hood is now president of Carnegie-Illinois Steel Corp. Messrs. Austin, Reed and Rooney are now vice presidents of United States Steel Corp. of Delaware, and Mr. Blough is secretary and general solicitor of that subsidiary. The president and these five executive vice presidents will constitute an executive committee of this single company, of which committee Mr. Fairless will be chairman and Mr. Hood, vice chairman.

"After January 1, 1951, the present sales offices of Carnegie-Illinois will be conducted in the name of United States Steel Co. There will be no change in the present customer relationships of Carnegie-Illinois. The new program does not affect the other subsidiaries of the corporation, which will continue in business as in the past."

EXHIBIT TRAIN COMPLETES ONE-THIRD OF TRIP

The General Electric Co. "More Power to America Special," has completed the first third of its trip schedule. Starting in April, 1950 the exhibit train has visited 51 cities covering a distance of 5660 miles. Shown during the Pittsburgh visit are: S. Littlejohn, General Electric Co., Admiral Ben Moreell, Jones & Laughlin Steel Corp., C. A. Ilgenfritz, U. S. Steel Corp., J. L. Young, National Tube Co., and C. F. Hood, Carnegie-Illinois Steel Corp. According to C. A. Falkenau, GE tour manager, the train, which houses over 2000 industrial products, will visit 150 cities covering a distance of 30,000 miles. The crew of 47 persons who live on the train are augmented by local office personnel in the districts visited by the train. Invited representatives from industry and government are averaging 900 persons per day.

CONTROLLER FIRM MOVES PHILADELPHIA OFFICE

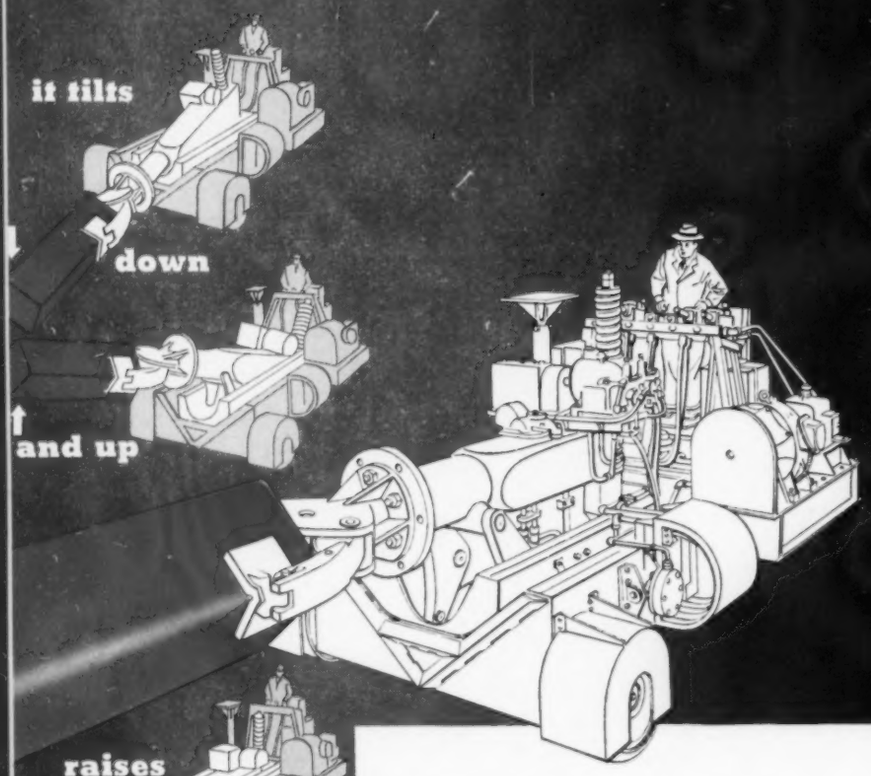
▲ The Philadelphia office of Electric Controller & Mfg. Co. has moved to new and larger quarters in the Times-Medical Bldg., Ardmore, Pa. District Manager is H. K. Hardcastle. Messrs. G. S. Steffey, O. J. Archer, I. H. Peak and Miss G. E. Edwards are all settled in the new location.

ACID OPEN HEARTH GROUP PLANS TO EXPAND

▲ The directors and research staff of the Acid Open Hearth Research Association held their first fall meeting on October 10 at the Roosevelt Hotel in Pittsburgh. This group is comprised of 12 steel companies and 15 plants manufacturing steel by the acid open hearth process and have been in cooperation on this research program for eight years. Any company having furnaces of this type may become a member of the Association. Six meetings of the Technical and Executive Groups are held each year.

At the meeting on October 10, methods were discussed for extend-

agile*



*Amazingly enough, you'll find *agile* an apt description of the massive Brosius Auto Floor Manipulator at work on your forging floor. With swift agility it draws or charges — turns on a dime and moves with independent facility — manipulates the billet or blank with remarkably sensitive movements. And each unit possesses the inherent sturdiness and sensible simplicity so typical of Brosius products. Brosius manipulators will bring to your forge shop added speed, added safety, added economy — you should be using them. Write for literature.

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ing the membership so as to permit some of the smaller companies to become members more equitably. A program whereby the annual research stipend is charged on the basis of tonnage of steel produced was considered. Sufficient reserve funds are available to permit continued research for several years.

The research progress was discussed in detail by the members of the research staff. The recent accomplishments of the research staff include the development of a Pt-PtRh immersion thermocouple for acid open hearth use; the development of a method for determining metal fluidity and a method for the determination of oxygen in steel. The latter procedure is similar to the carbon combustion method. Considerable advances have been made which have contributed to both the quality of the product and the rate of production in acid open hearth furnaces.

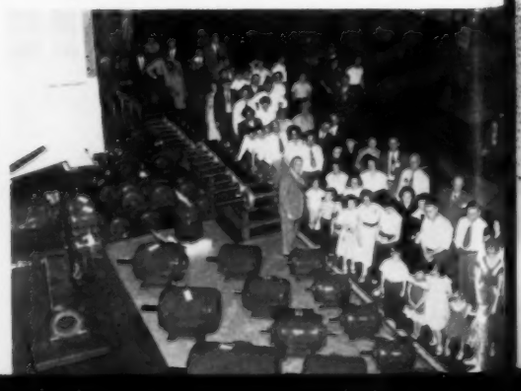
This Association represents 70 per cent of acid open hearth steel tonnage of the United States.

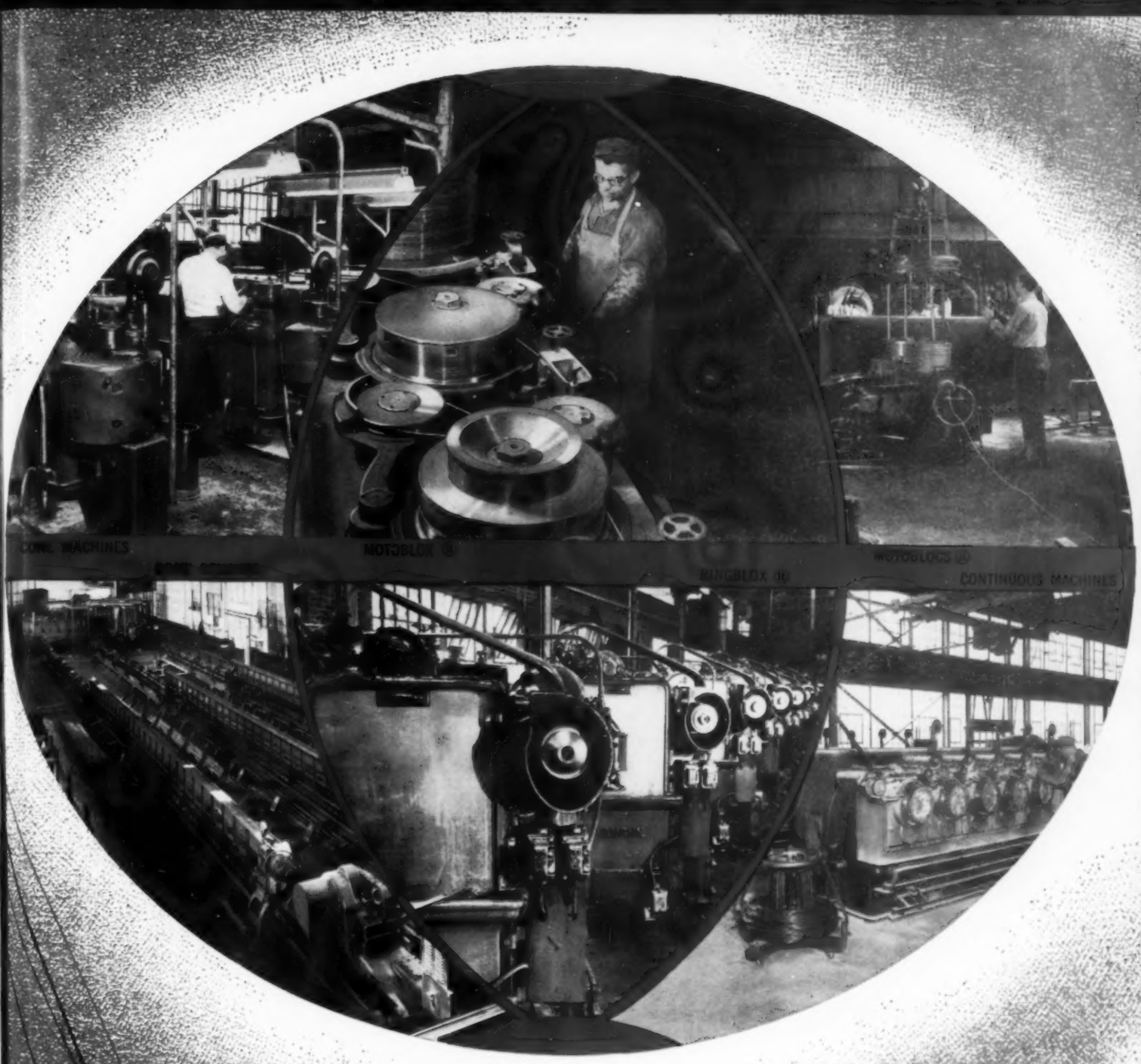
15,000 ATTEND WAGNER PLANT VISITATION

▲ Wagner Electric Corp. conducted a successful plant visit on October 14 and 15 at their main plant in St. Louis, Mo. More than 15,000 people toured the entire plant. Tickets were issued to all employees by their shop foremen or supervisors and permitted them to bring their families, friends and neighbors. Written invitations were sent to all Wagner stockholders, suppliers and customers; to schools, clergy and officials of the city and surrounding communities.

The general purpose of the event was to acquaint all guests with the large number of electrical and auto-

Employees invited friends and neighbors to visit the Wagner Electric plant in St. Louis.





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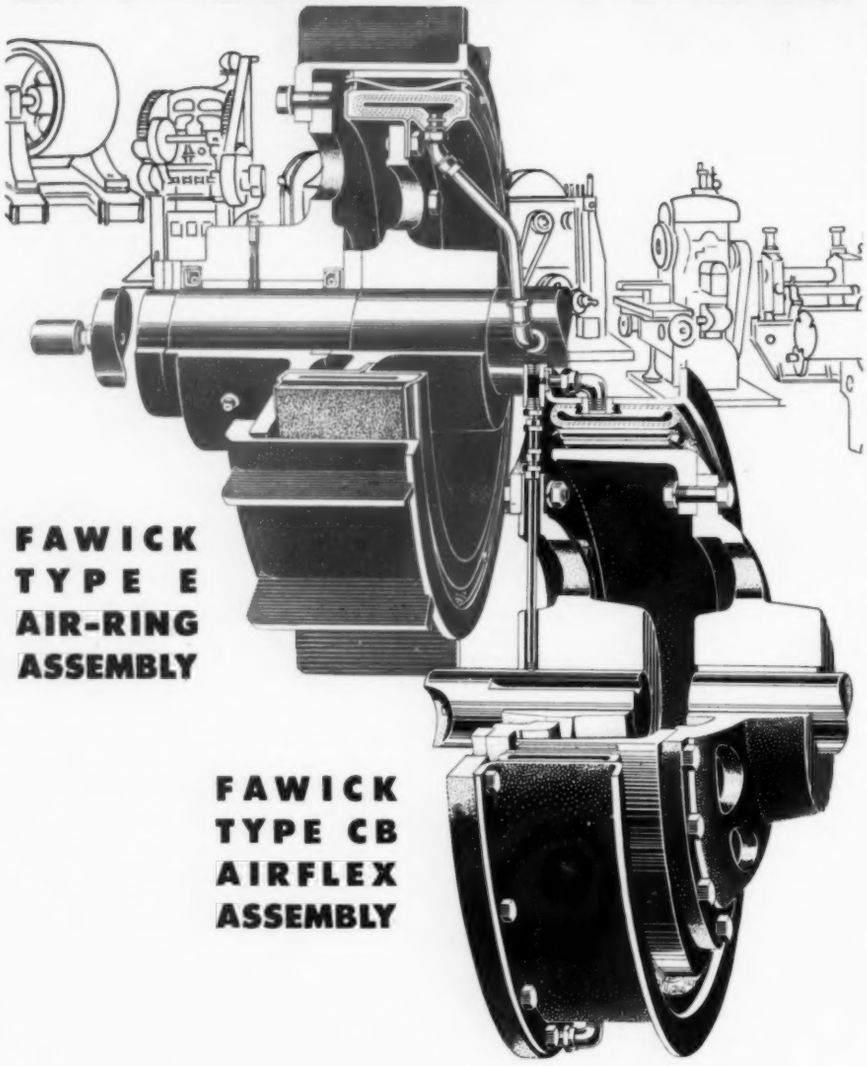
EFFICIENCY TWINS



FAWICK TYPE E AIR-RING ASSEMBLY

FAWICK TYPE CB AIRFLEX ASSEMBLY

FOR POWER TRANSMISSION

When machine specifications call for efficiency, the logical answer is Fawick Clutches and Brakes.

Working individually or in combination, they provide Fawick-equipped machines with those operating characteristics which result in top machine performance. Quick response, positive action and control, elimination of lubrication, mechanical linkage and clutch adjustment comprise some of these advantages. The rugged design and construction provide long trouble-free machine operation in heavy-duty service.

For specific information on all advantages of Fawick Industrial Clutch and Brake Units, write to the Main Office, Cleveland, Ohio, for Bulletin 300.

All desirable clutch characteristics are built into Fawick Airflex units

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motive products that Wagner manufactures and sells; to show their modern production equipment; and to demonstrate the contribution that this company and its 7300 employees are making to the welfare of the community. A special exhibit of all Wagner products was displayed in the plant cafeteria, and visitors were given an opportunity to inspect production and assembly lines throughout the factory.

SLOSS-SHEFFIELD ADDS COKE OVENS

▲ Sloss-Sheffield Steel and Iron Co. of Birmingham, Ala., has awarded Koppers Co., Inc., a contract to construct a new battery of 30 coke ovens at its Birmingham, Ala., plant. Cost of the new ovens will be in the neighborhood of $2,000,000.

Sloss-Sheffield now has two batteries of 60 ovens each at its Birmingham plant. The new battery of Koppers ovens will raise the total to 150 and will give the Birmingham firm a coal carbonizing capacity of 3280 net tons per day as compared to 2700 net tons now.

Work on the new ovens is to start at once and will be pushed to completion as rapidly as possible.

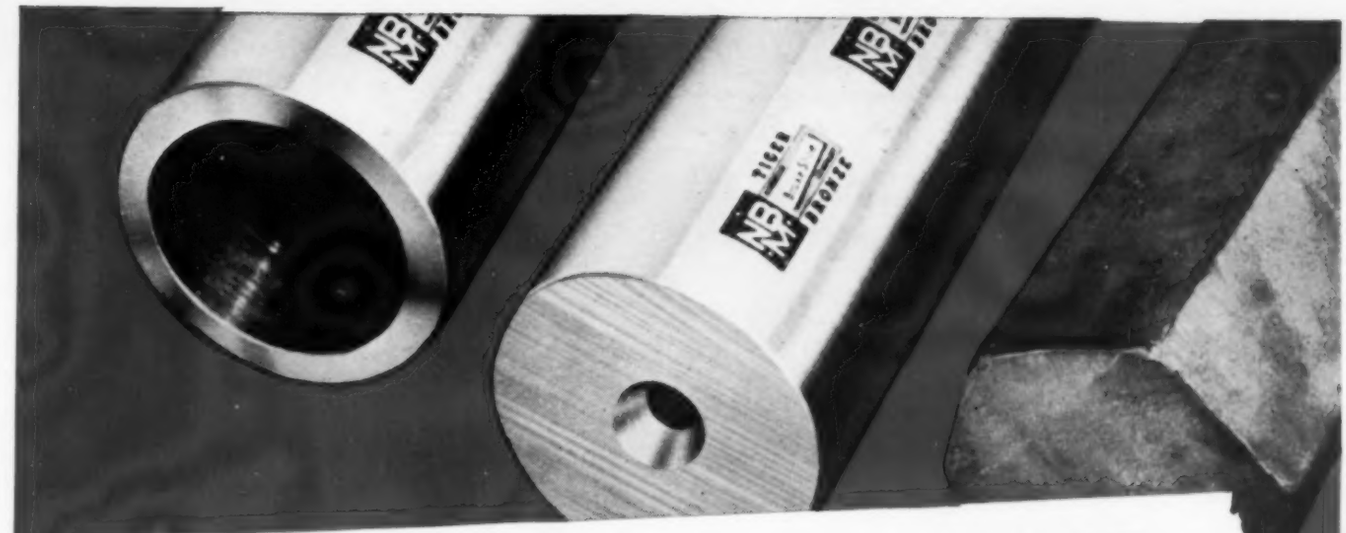
MEASUREMENTS LAB OPENED AT LYNN, MASS.

▲ General Electric Co. recently officially opened its new measurements laboratory at Lynn, Mass.

The new laboratory staffed by engineering specialists, contains complete facilities for applied research product development and design in the field of measurements.

Located on the site where one of the predecessor companies of G-E, the Thomson-Houston Electric Co., was founded in 1883, the five-story

The new measurements laboratory building contains 142,000 sq ft of floor space.



DIRECT-TO-YOU SHIPMENTS OF BRONZE BAR STOCK CUT BEARING COSTS!

Stocks of N-B-M "Tiger" Bronze now located for fast delivery of the bar size you want, when you want it.

National Bearing Division has announced a new direct-shipment policy on "Tiger" Bronze Bar Stock—a policy designed to substantially reduce costs of bearings, *used for plant maintenance or on production lines.*

Stocks have been conveniently "spotted" to assure fast delivery. All popular sizes in 13" lengths are available—as-cast or machined cored and solids, or as-cast hexagons.

Product Designers and Plant Engineers with an eye on bearing costs are urged to get the complete facts.

Inquiries receive prompt attention.

"TIGER" BRONZE . . . the ONE Bronze Alloy with ALL these features for longer bearing service at lower cost . . .

WEAR-RESISTANT—Has correct balance between bronze matrix and lead. *Lasts longer.*

ANTI-FRICTIONAL—Low coefficient of friction helps prevent shaft seizure. *Saves power.*

SHOCK-RESISTANT, EMBEDDABLE—Hard enough to stand up under heavy bearing loads. Soft enough to embed foreign material. *Protects the shaft.*

EASY TO MACHINE—With speeds as high as 3000 F.P.M. *Saves time.*

USE THIS COUPON—*for price quotations by return mail, and new bulletin giving complete FACTS on physical properties, operating characteristics, bar types and sizes.*

Please send me your new Cored and Solid Bar Bulletin and prices on "Tiger" Bronze:

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brick, steel and concrete building contains 142,000 sq ft of floor space, the major portion of which is occupied by the laboratory and associated engineering groups, the remainder by administrative staffs of the G-E meter and instrument divisions.

ARMCO TO IMPROVE EAST WORKS PLANT

▲ Armco Steel Corp., Middletown, Ohio, will build a blast furnace and coke ovens, enlarge its soaking pits, and make other improvements at its East works plant. Cost of the project will be $35,000,000. About 600 new jobs will be created. At the same time it was revealed that the Sheffield Steel Corp., an Armco subsidiary, is building a large electric furnace at its Houston, Tex., plant, and will shortly begin construction of another furnace, either an electric or an open hearth, at its Kansas City plant.

The announcement was made by Charles R. Hook, chairman, a few minutes before Armco started its new $12,000,000 open hearth plant, which represents the latest word in steel-making and has a capacity of over 400,000 tons of steel ingots per year.

"During the next two years Armco's steelmaking capacity will increase more rapidly than at any period in our history," Mr. Hook said. "On July 1, 1950, our rated capacity was 3,793,000 tons. By the end of 1952, expansion projects under way or just announced will result in an increase of 1,017,000 tons annually or about 27 per cent. This will bring our annual capacity to 4,810,000 tons.

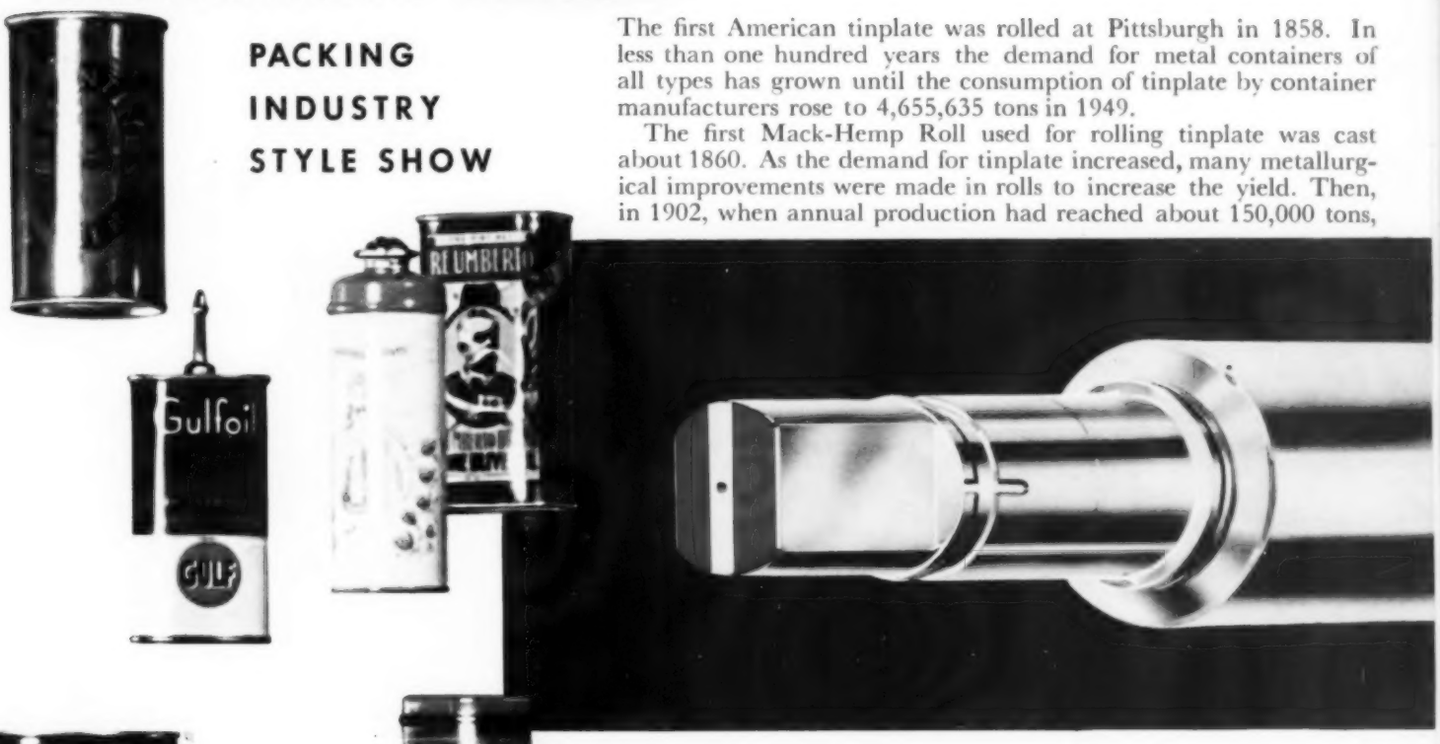
"Principal places where increases in capacity will be made are 580,000 tons at Middletown; 150,000 tons at Houston, Tex.; 150,000 tons at Kansas City; and 137,000 tons at Ashland, Ky., where a modernization program was announced a few weeks ago," Mr. Hook stated.

The new Armco blast furnace, one of the largest in the world, will have a capacity to produce 1500 tons of pig iron per day. An ore storage yard, with car dumper, will be constructed, capable of holding 1,000,000 tons of ore. Approximately 75 by-products coke ovens will be built as well as a by-products plant to recover coal tar, nitrogen, and other valuable chemicals.

Plans for the huge construction

Metal Containers

PACKING INDUSTRY STYLE SHOW



The first American tinplate was rolled at Pittsburgh in 1858. In less than one hundred years the demand for metal containers of all types has grown until the consumption of tinplate by container manufacturers rose to 4,655,635 tons in 1949.

The first Mack-Hemp Roll used for rolling tinplate was cast about 1860. As the demand for tinplate increased, many metallurgical improvements were made in rolls to increase the yield. Then, in 1902, when annual production had reached about 150,000 tons, Mack-Hemp developed the 3-stand continuous cold-rolling method for tinplate and set the stage for the transition to cold reduction of black plate.

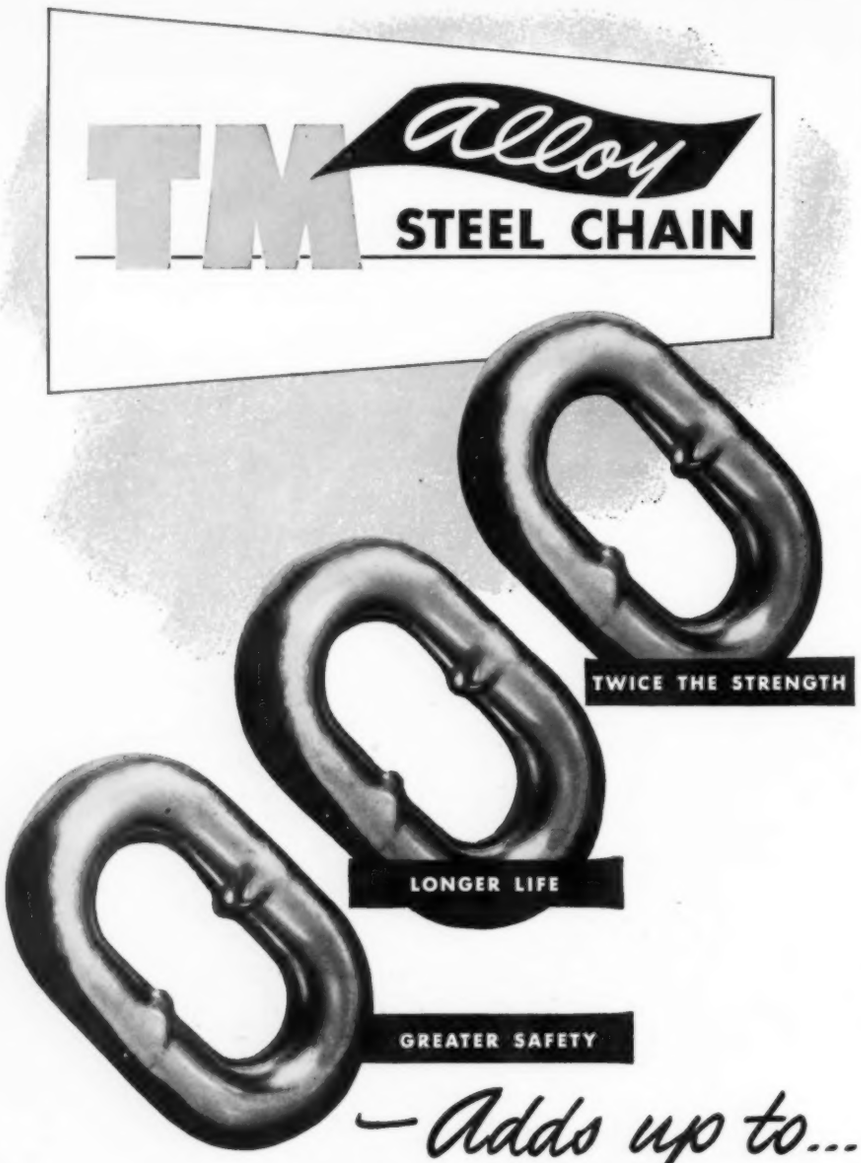
Improvements in striped red wabbler rolls paralleled the developments in mills and rolling methods, and in 1928 Mack-Hemp introduced the first nickel chill "NICHILLITE" rolls with the close grain structure required for smooth finishing cold-rolled plate. Further refinement in rolls for modern tinplate mills occurred when the "NIRONITE" roll was produced. Both "NICHILLITE" and "NIRONITE" rolls have records of service that prove it's worthwhile to keep an eye on what's new at Mack-Hemp.

MACKINTOSH-HEMPHILL COMPANY

Makers of the Rolls with the Striped Red Wabblers

PITTSBURGH AND MIDLAND, PA.

MACKINTOSH-HEMPHILL PRODUCTS INCLUDE: rolls . . . steel and special alloy castings . . . completely integrated strip mills . . . heavy duty engine lathes . . . the new Mackintosh-Abramsen straighteners . . . improved Johnston patented corrugated cinder pots and slag-handling equipment . . . shape straighteners . . . end-thrust bearings . . . shears . . . levellers.



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Lower Chain Costs!

Reverse rising chain costs with TM Alloy Steel Chain. It's super safe. It *stays on the job five to fifteen times longer*—has twice the tensile strength of wrought iron chain. TM Alloy Steel Chain is completely heat-treated for link to link uniformity. Extreme toughness and great resistance to shock, grain growth and work-hardness eliminate periodic annealing costs. Call your mill supply distributor today for more details or write Dept. 5, for Bulletin 12A.

This Registration Ring bears the chain's serial number. It's your assurance of thorough testing and inspection before shipment.

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Chain SINCE 1873

project have not yet been completed. Contracts will be let as soon as the engineering work advances.

STEEL RAIL LIFE AVERAGES 18½ YEARS

▲ If all the 1.2 billion tons of freight traffic hauled by American railroads last year was carried over the same steel rail on a straight track, the top of the rail would be worn down only three-tenths of an inch, according to American Iron and Steel Institute.

The remarkably long life of rails under the pounding of heavily loaded trains is shown by relating railway mileage statistics to the production figures for steel rails. At the 1949 rate of rail production, thirty-seven years would be required to replace the 70 million tons of rails in the country's 400,000 miles of track. In a 30 mile stretch of main line track the ages of the rails may vary from veterans laid down in 1927 to newcomers of 1946.

For about 18½ years, on the average, a rail remains in main line service, according to a 1947 survey of 31 roads. Some rails remain in main lines much longer than that. Others are removed earlier, particularly if they are subject to heavy punishment on curves.

Steel rails are one of the bargains offered by the steel industry. For only a few cents a pound the buyer gets a product manufactured to more rigid specifications, and tested and inspected more exhaustively, than any other heavy product of the in-industry.

SHEET & TUBE PLANS IMPROVEMENT PROJECT

▲ Youngstown Sheet & Tube Co. will spend nearly $9 million on improvements to its Youngstown, Ohio, district plants.

The company's projected Youngstown district plant improvements represent work for which directors already have appropriated money but which has not been completed. Plans include some changes in the electric weld pipe mill, improvements to by-product coke plants, new cranes and larger ladles at the Campbell works open hearth plant. It is estimated the new installations will boost the Campbell works ingot capacity by 75,000 to 100,000 tons a year.

On slab heating furnaces . . .

. . . this nameplate identifies the combustion control system which gives *precise* control of fuel air ratio—and hence maximum production of high-quality steel.

Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

HAGAN HALL BUROMIN CALGON

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METALLURGICAL FURNACE CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
BOILER COMBUSTION CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

KOREA IS RICH IN MINERAL DEPOSITS

▲ Although Korea covers an area only a little larger than the state of Utah, it is rich in mineral deposits, according to American Iron and Steel Institute, based upon a study of Bureau of Mines figures. In 1948, Korean mines shipped nearly 3.6 million pounds of tungsten ore to the United States and were the second largest source of imports. In the same year, South Korea was the world's second largest producer of graphite, which is used in making electrodes for electric steelmaking furnaces. Fluorspar and molybdenum mines south of the 38th parallel showed production gains during 1949.

In 1944, under Japanese domination, Korea was the world's second largest producer of tungsten ores, ranking only after the United States in output. In the same year, South Korea alone was the sixth largest world source of molybdenum. Korea also ranked eleventh of the 37 manganese producing nations. Under Japanese control, Korea became the world's fifth largest producer of fluorspar, and the only major source in the Orient.

Iron mines are found in both North and South Korea, but good coking coal is lacking. In addition, Korea has aluminum, cobalt, copper, nickel, magnesite, lead, vanadium and zinc mines. These elements are all used in the manufacture of steel or steel products.

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INSTRUMENTS AND CONTROLS FOR EVERY NEED

TO IMPROVE MANY PHASES OF STEEL PROCESSING... AND TO CUT YOUR FUEL AND LABOR COSTS.

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Annealing
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Flow
Furnace Draft
Fuel air-ratio
Gas analysis

Inquiries invited on any of these specific applications.

The bulletin illustrated is not just a piece of sales literature but a complete 24 page treatise on the instrumentation and automatic control of steel making and heat treating furnaces. You'll want a copy for your reference files, want to profit from its practical, authoritative information.

And remember as you read it, Hays engineers are thoroughly qualified and ready to work hand-in-hand with you in solving your own specific instrumentation and control problems . . . without obligation.

Write for your copy today . . . Ask for Bulletin No. 48-750 (covering heat-treating furnaces). Companion edition covering open-hearth furnaces will also be included.

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Since 1901 COMBUSTION & INDUSTRIAL INSTRUMENTS & CONTROL
MICHIGAN CITY, INDIANA, U.S.A

H. K. PORTER SELLS LOCOMOTIVE BUSINESS

▲ H. K. Porter Co., Inc., has announced the sale of its locomotive business, including patterns, drawings, and spare parts business, to Davenport-Besler Corp. (Davenport Locomotive Works), Davenport, Ia.

The sale included an agreement that Davenport-Besler would service all Porter locomotives now in use. Davenport-Besler will not only service all Porter locomotives now in operation but will also build duplicate Porter locomotives, including the Porter fireless locomotives. This arrangement was made possible by including all drawings in the purchase.

FURNACE FIRM REBUILDS JAPANESE SOAKING PITS

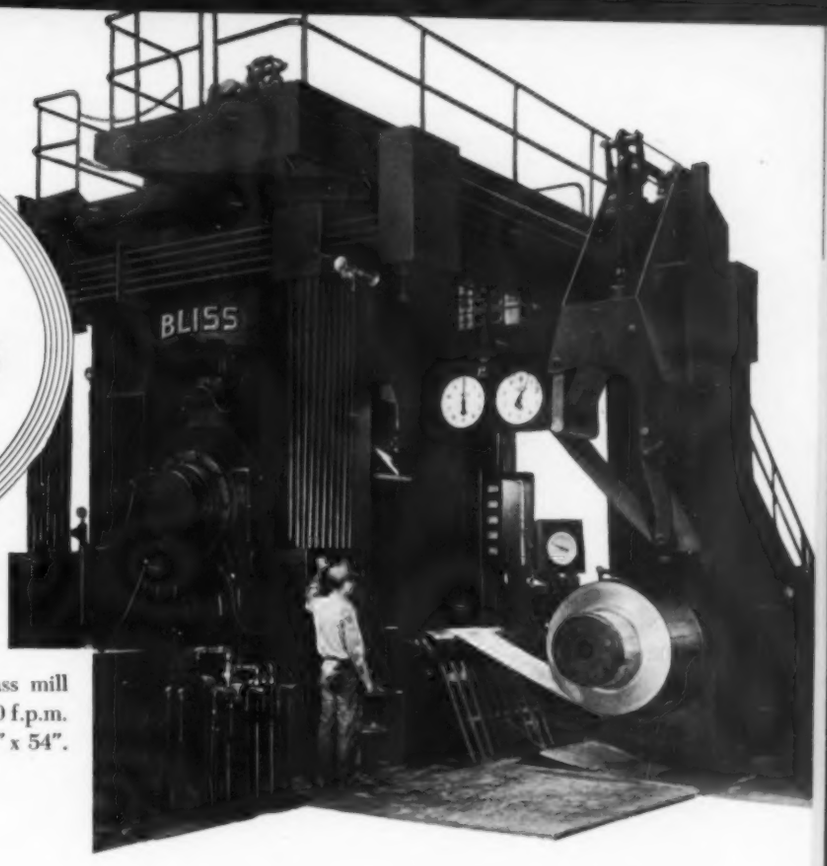
▲ The job of rebuilding 4 batteries of soaking pits in Japan has been placed with Furnace Engineers, Inc., Pittsburgh, Pa. While the amount of the contract was not disclosed it is of considerable size, covering a total of 60 soaking pits, according to Harry Dobrin, president of Furnace Engineers, Inc.

ARMCO EXPANDS MANUFACTURING PLANT

▲ A $150,000 expansion program for the new Armco manufacturing plant in Washington Court House, Ohio, has been announced.

The expansion plans call for the addition of two bays totaling 24,000 sq ft of floor space to the existing building. The new facilities will be

South's Leading Steel Plant Specifies Bliss Again!



This new Bliss temper-pass mill rolls 20-gauge steel at 3,000 f.p.m. It is four high, 21″ and 53″ x 54″.

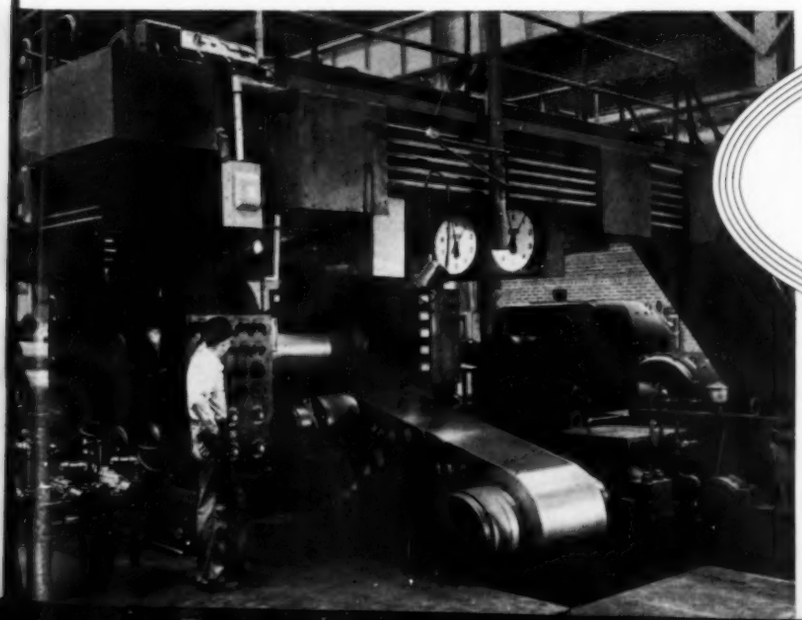
This four-high temper-pass mill and a two-high sheet and coil mill are the latest additions to the complete array of Bliss rolling mill machinery, producing quality steel and tinplate at the South's leading steel plant.

Both Bliss mills have operated continuously since early 1949 to keep pace with the company's growing demands from Southern industries. They have met every test in finish rolling a full range of steel from 30 to 13 gauge, 20″ to 48″ wide, at maximum speeds. Last month the four-high mill rolled a record 652 tons in an eight-hour day.

Tinplate (750 tons daily) is rolled to can-makers' precise "Specs" for flatness and temper in five Bliss two-stand tandem mills installed in 1938. They are delivering production even beyond rated capacity.

In hot working, too, rugged Bliss mills are key equipment. A scale breaker and six-stand, four-high tandem mill reduce hot steel slabs at the rate of 2,000 feet per minute.

Next time you need rolling mills or accessories call a Bliss engineer. He will be glad to analyze your equipment problem and submit recommendations without obligation.



Both sheet and coil steel, from 30 to 13 gauge—20″ to 48″ wide—are finish rolled in this new Bliss two-high mill.

E.W. Bliss Company

General Office: Canton, Ohio

Rolling Mill Division

Salem, Ohio

used principally in the manufacture of certain types of steel buildings.

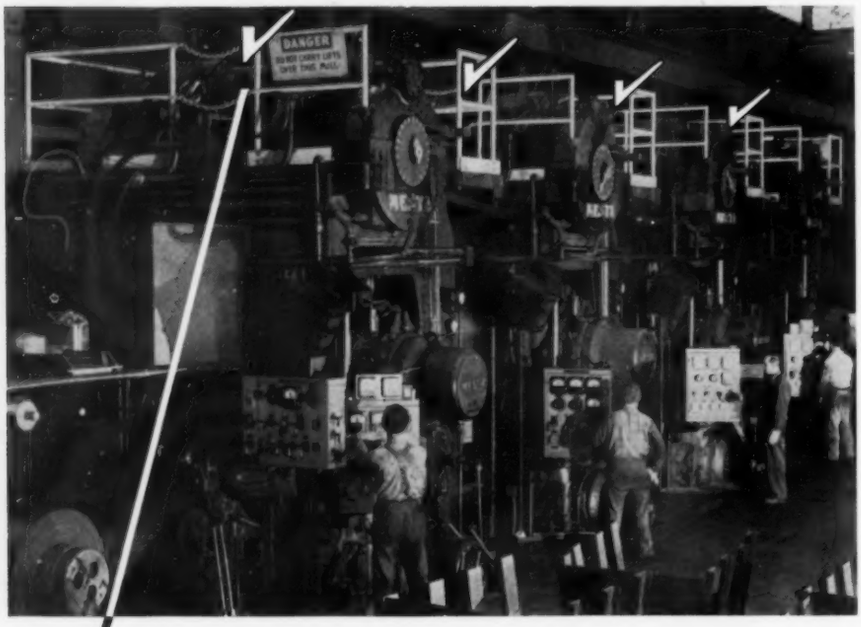
One of the bays will be 60 by 220 ft, the other, 60 by 180 ft. Both will be factory type steel buildings manufactured by the company and similar in appearance and construction to the original building. When completed the buildings will form a U-shape, with a concrete floor in the open section for a loading dock and storage area. The addition will almost double the present roofed area of the plant.

ALLIS-CHALMERS BUYS CANADIAN PLANT

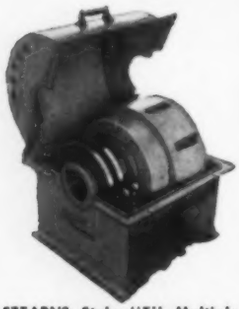
▲ Allis-Chalmers Rumley, Ltd., a Canadian subsidiary of Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has announced the purchase of the plant of the Erie Iron Works at St. Thomas, Ontario, and also the purchase from the city of an additional seven acres of land.

According to W. C. Johnson, executive vice president in charge of the parent company's general machinery division, Allis-Chalmers took possession of the new site October 9. By the first of the year, the company hopes to install machine tools for manufacturing operations. Until that time, however, assembly operations will be carried out. The plant was completed in 1948 and has 19,000 sq ft of floor space.

Mr. Johnson said that besides the purchase of the plant and the adjoining seven acres, an option was taken by Allis-Chalmers on an additional 24 acres of land. The general machinery division for the present plans to manufacture and assemble products that will become component parts of finished equipment.



Stearns KEEPS THEM ROLLING AT ALLEGHENY LUDLUM



STEARNS Style "E" Multiple Disc Magnetic Clutch fully enclosed in steel housing for steel mill application.

Synchronizing the drives of the screwdowns of a large mill requires a rugged, dependable clutch — a STEARNS Multiple Disc Magnetic Clutch. That's exactly the story of this installation, told four times! On each stand of this Mesta four high cold rolling mill at the Allegheny Ludlum Steel Corp., West Leechburg, Pa., there is a STEARNS Magnetic Clutch to synchronize the screwdown drives.

The newest and most powerful for its size, it is natural that this strip mill incorporate STEARNS Magnetic Clutches. Designed for just such steel mill applications, the STEARNS clutch is a low inertia unit of simple construction with no toggles, pins, yokes, shifters or other parts to wear and get out of order. Controlled by a push-button station, STEARNS clutches are available with taper-bores, detachable magnet hub, torques and construction to meet your screwdown requirements.

STEARNS EQUIPMENT FOR STEEL MILLS

Circular and Rectangular Lifting Magnets
Sheet and Pipe Conveyor Rolls
Magnetic Brakes and Clutch-Brakes
Drag Magnets and other steel mill magnetic specialties

Stearns MAGNETIC MANUFACTURING CO.
681 S. 28th St., Milwaukee 46, Wisconsin

PORTER ACQUIRES CONNORS STEEL CO.

▲ In a move to further diversify its manufacturing operations H. K. Porter Co., Inc., Pittsburgh, Pa., has acquired Connors Steel Co., Inc., of Birmingham, Ala., producers of electric furnace steel and steel products.

Connors Steel Co., one of the south's leading manufacturers of light steel products, produces steel billets from scrap by the electric furnace method and operates a series of rolling mills to manufacture finished products. The plant's total capacity exceeds 94,000 tons yearly.

With the acquisition of the Connors Steel, Porter has added to its list of diversified products cotton bale ties, hoops, fence posts, concrete reinforcing bars and many other light steel products manufactured at the Birmingham plant.

Porter Company, through its various divisions, now manufactures products ranging all the way from rubber to steel, with Quaker Rubber Corp., Philadelphia, manufacturing industrial rubber products; Hinderliter Tool Co. division, Tulsa, Okla., producing oil well equipment, valves and air brake parts; American-Fort Pitt Spring division, Pittsburgh, Manufacturing industrial and railroad springs; and the newly acquired Connors Steel Co., producing steel and steel products. In addition to these manufacturing plants Porter operates a group of oil field equipment supply stores through its Jarecki Manufacturing Co. division, Houston, Tex.

stop coupling failures!

FIND OUT HOW *Koppers Engineers Eliminate Needless Downtime* IN YOUR PLANT!

These FAST'S COUPLING *Services save you money!*

UNSURPASSED ENGINEERING . . . Koppers engineers are acknowledged the best in the industry. Their practical knowledge, backed with 30 years' coupling experience, is at your service!

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For *30 years,* Fast's Couplings have been industry's standard for *long life* at *low cost.* Now, in addition, when you specify Fast's you get the *extra* advantage of Koppers valuable Engineering Service. Koppers engineers, backed with 30 years of Fast's Coupling experience, study your problem. Then show *which* Fast's Coupling you need (and more important) *why you need it!*

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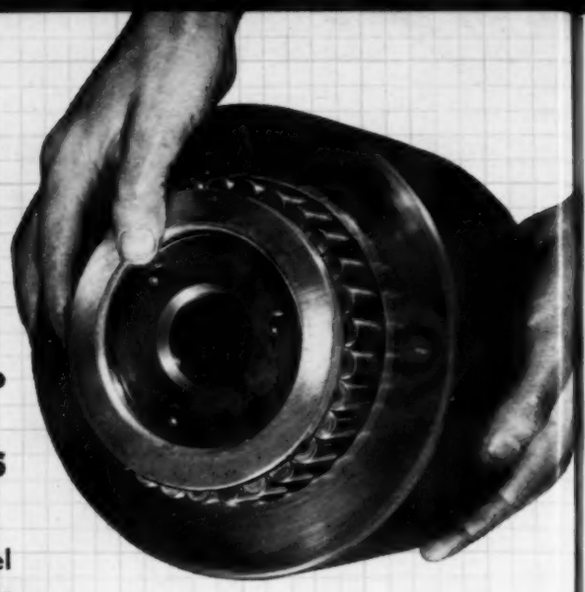

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Sendzimir cold strip mills, engineered by Armzen Company, do it by using small diameter work rolls, rigidly backed by precision Torrington Bearings through the intermediate rolls. These bearings carry the tremendous loads and allow the mill to start and stop without re-setting the gage.

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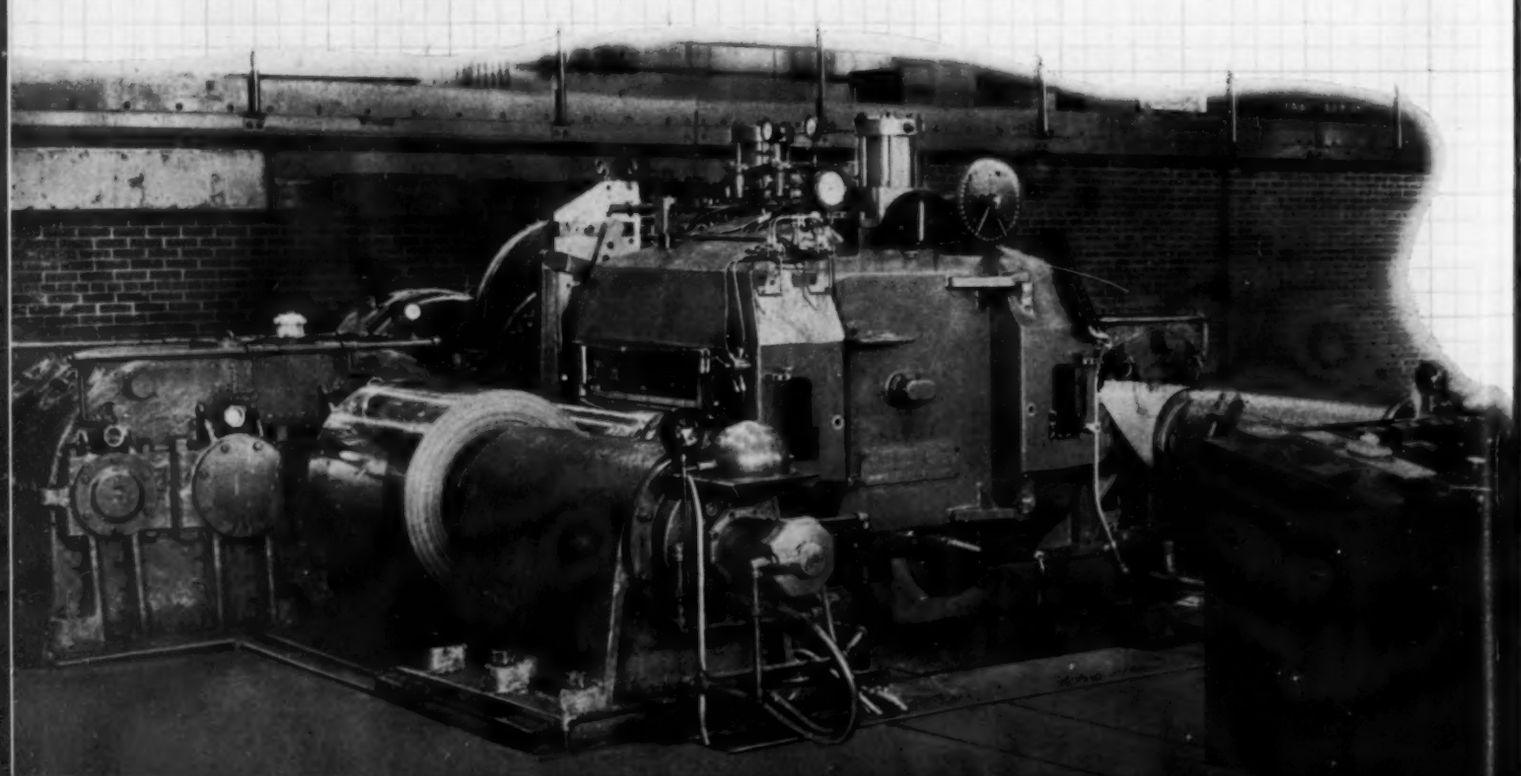
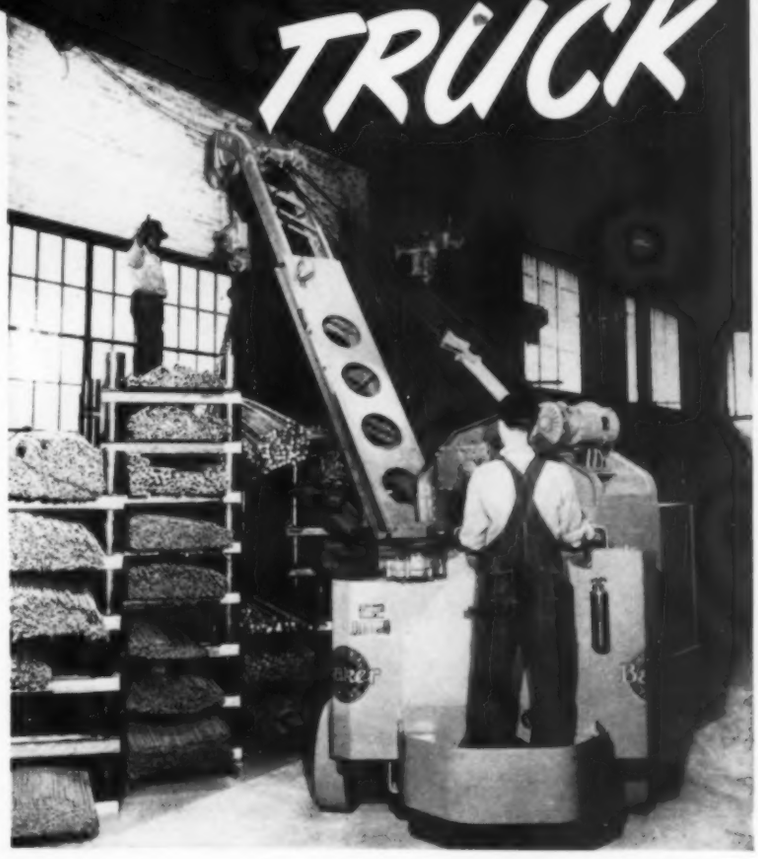


Cost of Handling Steel Bars Cut in Half *with* BAKER TRUCK

JONES & LAUGHLIN DETROIT WAREHOUSE USES CRANE TRUCKS AND PORTABLE RACKS FOR MORE EFFICIENT HANDLING AND STORAGE



★ Specially designed portable sectional racks for storing steel bar and rod stock plus the use of a BAKER Crane Truck have cut handling costs by one-half at the Jones & Laughlin Steel Corporation's Detroit Warehouse. This stock was formerly stored by hand in upright position, requiring laborious manual handling. Even with overhead cranes, considerable hand labor was necessary. Previous to the purchase of the truck and the installation of the portable racks, Jones & Laughlin used 6, 8, or more men to pile steel and fill orders. The entire operation is now handled by three men.

With the Baker Crane Truck and sectional storage racks, costs have been halved—and the crane truck still has time to handle steel packs—a further saving not anticipated when it was purchased.

Illustration shows the BAKER Crane Truck handling steel bars stored on sectional racks set at 45° angles in 15 x 15 foot bays.

A Baker Material Handling Engineer will be glad to show you how similar savings can be made in your plant or warehouse.

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Personnel News...

Victor E. Schlossberg has been appointed assistant chief engineer of the Indiana Harbor works of Inland Steel Co. in an enlargement of the engineering department found necessary because of the extensive construction work involved in the expansion program of the plant. Mr. Schlossberg has been superintendent of the electrical, power, and steam departments since 1947. Departments formerly supervised by Mr. Schlossberg will be separated into the electrical department under **Ryland J. Beeswy** as superintendent, and the power and steam departments under **Noah R. Kirkdoffer** as superintendent. Both men have been assistant superintendents under Mr. Schlossberg.

John M. Walsh, Jr. has been appointed division superintendent of blast furnaces at Gary, Ind., works of Carnegie-Illinois Steel Corp., following the retirement of **G. Paul Burks.** Mr. Burks, who is retiring because of ill health, came to Gary works as a chemist in 1915. He was made division superintendent of blast furnaces in 1947. Mr. Walsh, who will be taking charge of the largest division of blast furnaces in the world, first joined U. S. Steel in 1931 as assistant special engineer, Carrie Furnaces, Homestead district works at Rankin, Pa.

Raymond W. Sundquist has been appointed assistant division superintendent of blast furnaces at the Gary, Ind., works of Carnegie-Illinois Steel Corp. Mr. Sundquist first joined the corporation as a laborer and stoveman at the South Chicago works in 1937. In 1938 he moved to Gary works as a practice apprentice. He began advancing through the important jobs in the blast furnace department in 1940 and by 1947 was named superintendent of blast furnaces.

R. H. Wright has been appointed general superintendent of the Atlantic Steel Co., Atlanta, Ga. Mr. Wright was previously assistant superintendent of the wire mills. **R. E. Bobbitt,** formerly chief engineer, was made superintendent of maintenance. **W. R. Potts** was made chief engineer.

S. C. Read, formerly manager of construction and maintenance, Jones & Laughlin Steel Corp., Pittsburgh, Pa., is now director of construction and maintenance.

Samuel W. Stouffer was appointed manager of construction, Jones & Laughlin Steel Corp., Pittsburgh, Pa. Mr. Stouffer was formerly resident construction engineer at Aliquippa works.

John B. Good, formerly construction schedule engineer, was appointed assistant to the manager of construction, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

Arthur Bender has been appointed construction project superintendent for Jones & Laughlin Steel Corp., Pittsburgh, Pa. Mr. Bender will be responsible for construction projects in the raw materials department, exclusive of the coal mines.

J. M. Jeffries, formerly assistant to the manager of construction and maintenance, has been appointed manager of maintenance for Jones & Laughlin Steel Corp., Pittsburgh, Pa.

John F. McQuillan was appointed assistant manager of maintenance, Jones & Laughlin Steel Corp., Pittsburgh, Pa. Mr. McQuillan formerly was assistant general maintenance foreman—labor, brick, and riggers at Pittsburgh works.

Paul H. Devaney was appointed general superintendent at Aliquippa works of Jones & Laughlin Steel Corp. succeeding **Howard F. Martin,** who has been transferred to the office of the vice president—operations as operations consultant. Mr. Devaney was first employed at Aliquippa works as a millwright helper in 1924. Since that time, he has advanced through various supervisory positions until his appointment in 1947 as assistant general superintendent. Mr. Devaney will be succeeded by **Alonzo C. Keller** who has been appointed assistant general superintendent. Mr. Keller started to work at Aliquippa in 1925 in the metallurgical department. He has been superintendent of the open hearth and bessemer department since January 1, 1948.

Maurice R. Graney was named superintendent of training at Indiana Harbor works, Ind., of Inland Steel Co.

Sherman S. Cross was appointed operations manager of Brainard Steel Co., Warren, Ohio. Mr. Cross had been chief product engineer since 1949.

M. G. Rice was appointed assistant superintendent of the LaBelle Agricultural department, Midland works of Crucible Steel Co. of America.

V. E. SCHLOSSBERG

R. J. BEESWY

JOHN M. WALSH, JR.

R. W. SUNDQUIST

John H. Hite was appointed superintendent (shops), maintenance division, at Carnegie-Illinois Steel Corp., Duquesne, Pa. Mr. Hite was formerly assistant superintendent (shops), maintenance division.

John Zeleznik was named assistant superintendent, merchant mill, Carnegie-Illinois Steel Corp., Duquesne, Pa. He formerly was assistant superintendent, conditioning department.

William J. Joyce was promoted to superintendent, merchant mill department, Carnegie-Illinois Steel Corp., Duquesne, Pa. Mr. Joyce was formerly assistant superintendent, No. 6 and No. 7 merchant mills.

Harry E. Berger has been appointed assistant superintendent, blooming mill department, Carnegie-Illinois Steel Corp., Duquesne, Pa. Prior to his appointment, Mr. Berger was general turn foreman, No. 5 merchant mill.

R. P. Liggett, chairman of blast furnace committee for Republic Steel Corp., Cleveland, Ohio, has been given additional duties as general superintendent of blast furnaces, Cleveland district. **J. M. Komp** was named general superintendent of the coke plant; **G. N. Harmon** was made assistant general superintendent of the 98-in. strip mill to replace **W. E. Boger** who resigned. **C. A. Tarter** will succeed Mr. Harmon as superintendent of the 98-in. cold strip mill and cold strip finishing department.

Joseph J. Jeffrey was appointed vice president in charge of personnel for Great Lakes Steel Corp., Ecorse, Mich. The action promotes Mr. Jeffrey from his previous position as personnel and industrial relations director. He will continue to supervise these activities.

James L. Sherwin, chief electrical engineer of Arthur G. McKee & Co., has resigned from the company in order to resume the private practice of consulting electrical engineering. He is opening offices in the United Bank Building Annex, 2537 Lorain Ave., Cleveland, Ohio.

J. W. Greene has been appointed to the newly created position of assistant manager of the Valve & Fitting department, Crane Co., Chicago, Ill. Mr. Greene has been sales manager of the New York branch office.

Colonel Willard F. Rockwell, chairman of the board of Rockwell Manufacturing Co., was elected to the board of directors and to membership on the executive committee of E. W. Bliss Co.

Ralph L. Robinson was named vice president of the Brake Shoe & Castings and Southern Wheel Divisions of the American Brake Shoe Co., with offices at 109 N. Wabash Ave., Chicago, Ill. Since joining the company in 1928, Mr. Robinson has served in various sales capacities. He has been assistant vice president since 1947 of the Brake Shoe and Castings and Southern Wheel Divisions, and has been located in St. Louis, Mo.

George Gabriel, who has been plant engineer at the Mertztown, Pa., plant at Atlas Mineral Products Co., has been promoted to assistant plant manager.

J. T. Farrell has been named assistant to the manager of sales of General Electric's small and medium motor divisions, according to a recent announcement by **Olaf F. Vea,** manager of sales. In addition to specific assignments, he will have supervision of the marketing and promotion division and a newly-created gearmotor and packaged drive sales division.

Chester R. Austin was named manager of the development section of the research department of Koppers Co., Inc., Pittsburgh, Pa. A native of Bellefontaine, Ohio, Mr. Austin was awarded bachelor of science and master of science degrees in ceramic engineering by Ohio State University. From 1929 to 1933 he was associated with the engineering experiment station of Ohio State University in ceramic research. From 1934 to 1948 he was engaged in ceramic research at the Battelle Memorial Institute in Columbus, Ohio. He joined Koppers research department as a ceramic engineering specialist in 1948.

John C. Augsburger, senior assistant to vice president of American Bridge Co., has retired after 50 years' service.

J. N. Forker, vice president and general manager of the Tar Products division, Koppers Co., Inc., since 1946, will retire on December 1, and **Fred C. Foy,** who has headed the Koppers sales department, will succeed him. Mr. Foy has been elected a vice president of Koppers and has been relieved as manager of the sales department in order to prepare to assume the division general managership on December 1. **Cooke Bausman, Jr.,** who has been assistant to Mr. Foy, has been appointed acting manager of the sales department, effective immediately.

J. M. Wallace has been appointed manager of the switchgear distribution apparatus department for the Westinghouse Electric Corp. In his new position Mr.

JOHN H. HITE

JOHN ZELEZNIK

WILLIAM J. JOYCE

HARRY E. BERGER

doing this *costs more* now!

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Wallace will be responsible for development engineering and sales activities of distribution fuses, cutouts, declosers, capacitors, lightning arresters, and the like. Early in 1949 he was appointed engineering manager of the switchgear distribution apparatus department, from which position he comes to his new duties.

Earl C. Hartman has been appointed supervisor of the coke oven refractories division at Harbison-Walker Refractories Co. A member of the company's sales

E. C. HARTMAN

force since 1930, Mr. Hartman has specialized in coke oven refractories for the past 12 years. He is a native Pittsburgher, and was associated for a short time with American Steel and Wire Co. before joining Harbison-Walker.

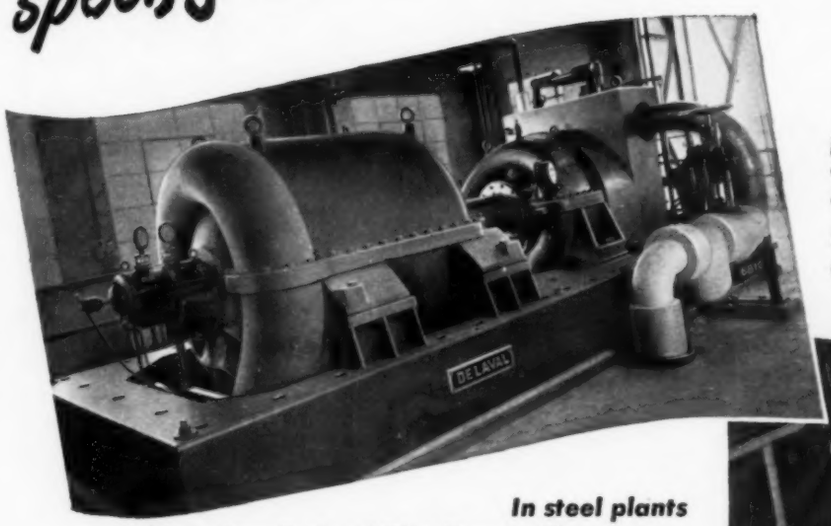
M. R. Hatch was named chief engineer in the press division of E. W. Bliss Co. His primary responsibility is the development and production engineering work

M. R. HATCH

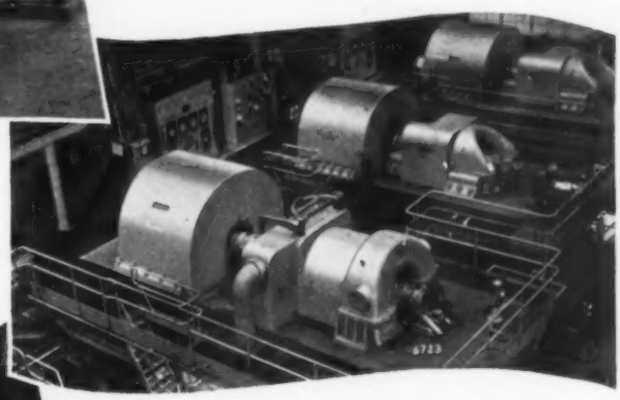
on large single-action mechanical presses. Mr. Hatch has been associated with Bliss sales engineering activities in the Detroit area for many years.

Raymond T. Porter has been appointed eastern sales manager of Heppenstall Co., Pittsburgh, Pa. Mr. Porter will supervise die block, shear knife, tongs, rings and other forging sales throughout the company's Boston, Bridgeport, New York and Philadelphia sales districts. Mr. Porter makes his headquarters at the offices of Heppenstall Co., Bridgeport, Conn.

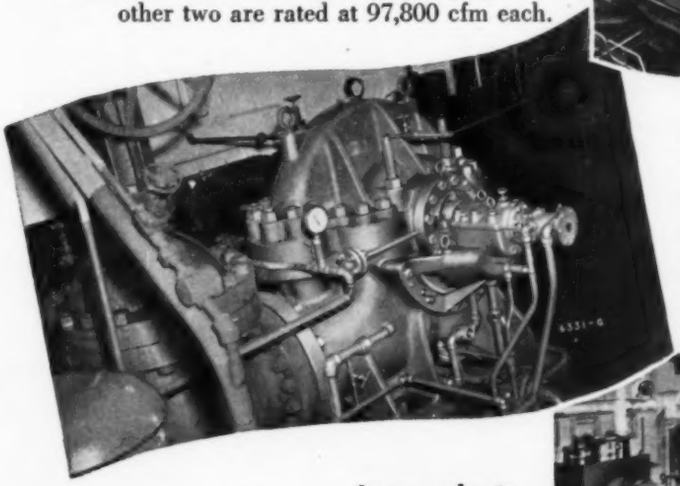
for Continuous Operation specify De Laval heavy Duty Blowers!



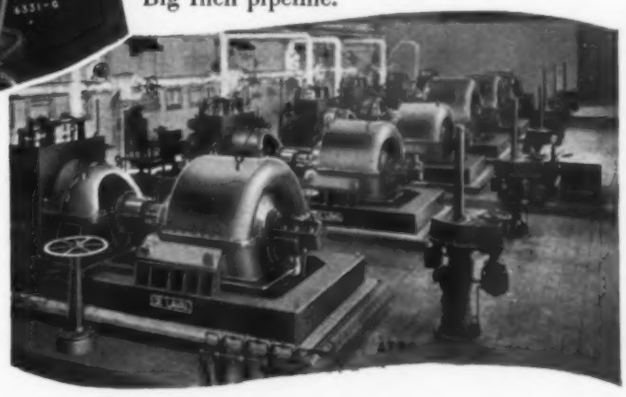
In refineries
This 1910 hp, 17,800 cfm De Laval Turbine Driven Blower supplies air for catalyst regeneration in a fluid catalytic cracking plant.



In steel plants
These three De Laval Blast Furnace Blowers serve one of America's leading steel plants—the largest unit is rated at 123,00 cfm against 33.3 psig. The other two are rated at 97,800 cfm each.



On pipe line service
This De Laval single-stage compressor pumps gas through the Little Inch pipeline at 850 psi. Similar De Laval units also are giving continuous trouble-free service at this high pressure on the Big Inch pipeline.



In gas plants
Three De Laval coke oven boosters and three coke oven exhausters installed in an Eastern Steel Mill.

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William P. Newdome was appointed a sales engineer for Furnace Engineers, Inc., Pittsburgh, Pa. Mr. Newdome graduated from Case School of Applied Science in June 1950, with a degree of bachelor of science in mechanical engineering.

Albert C. Ogan was promoted to superintendent, electric furnace department, Carnegie-Illinois Steel Corp., Duquesne, Pa. Mr. Ogan has been assistant superintendent, electric furnace department since June 30, 1950.

ALBERT C. OGAN

John B. Keeler, manager of the traffic and transportation department of Koppers Co., Inc., since 1947, has been appointed a vice president of Koppers.

Dr. R. W. Sandelin was named as head of the metallurgical department of Connors Steel Co., Birmingham, Ala. Dr. Sandelin completed his graduate work at the University of Minnesota where he received his Ph.D. in metallurgy. His early training in the steel industry was obtained in the south. During the war he served in the Army, being assigned to the Ordnance Department in the Birmingham district as technical advisor.

DR. R. W. SANDELIN

A. W. Anderson has been appointed Pittsburgh dis-

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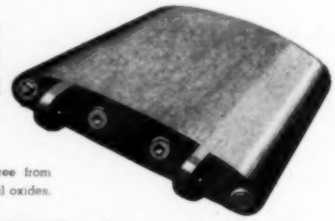

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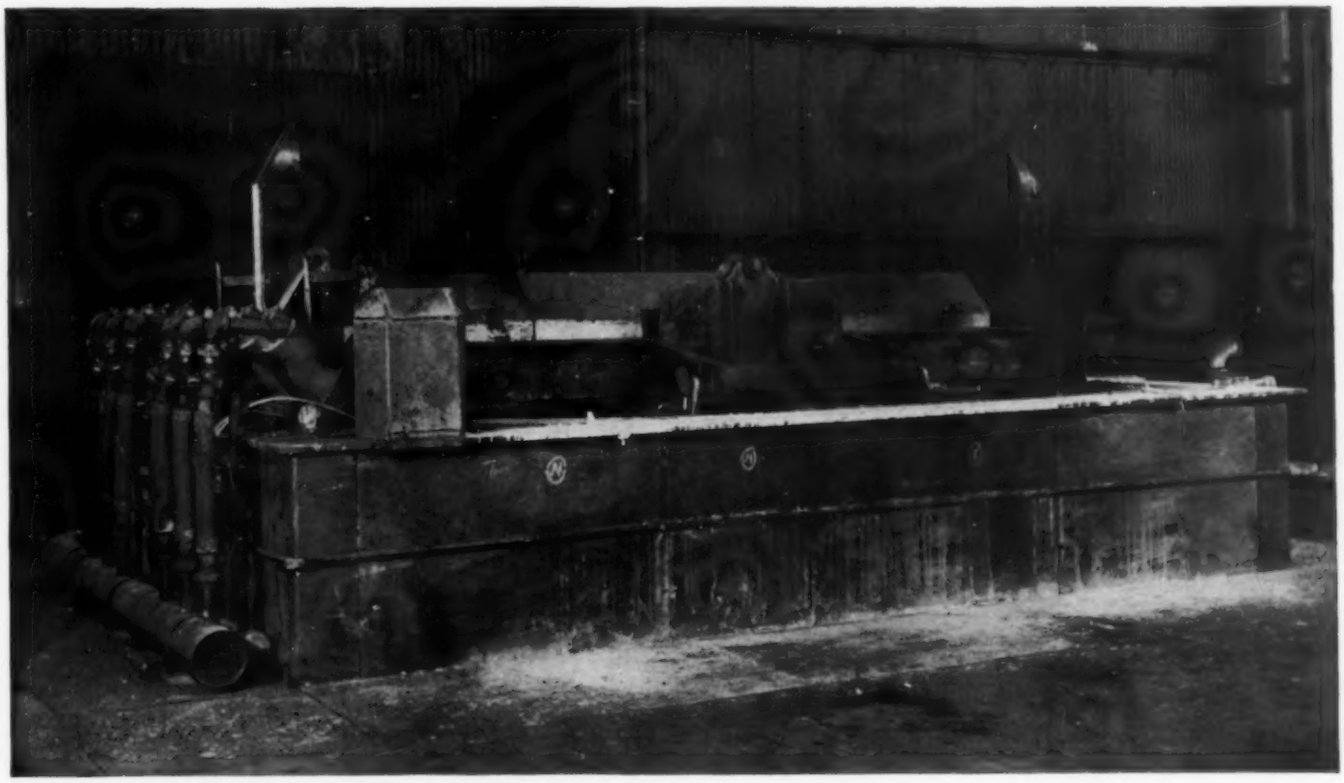

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8 tons of steel per hour is descaled in this 18 foot Drever caustic bath descaling unit installed in a leading steel mill.

Operating with automatic temperature control at 930° F, this bath shows no appreciable drop in temperature after the load is charged. The design is such that the unit is adaptable for other descaling processes.

The burners are so mounted that the scale pans are removable, thereby assuring complete ease of cleaning and resultant efficient operation.

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Drever descaling units are applicable to both batch and continuous operation, and include where desired: preheat furnaces, descaling, water quench, acid dip, and high pressure water rinse tanks as well as complete instrumentation.

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W. PENNA., W. N. Y. and OHIO — H. C. BOSTWICK, 19406 S. MORELAND BLVD., CLEVELAND 22, OHIO

trict sales representative for Ohio Steel Foundry Co., Lima, Ohio, replacing **Harry S. Ransom** who is retiring.

Harold R. Ryan has been appointed superintendent of the open hearth department at the Campbell works of Youngstown Sheet and Tube Co. Mr. Ryan succeeds **Thomas A. Cleary** who recently was appointed general superintendent of the Campbell works steel plant and Struthers works. For the last year Mr. Ryan has been superintendent of the company's open hearth department at the Brier Hill works.

Walter D. Evans has been named cost control engineer, construction department, Jones & Laughlin Steel Corp., Pittsburgh, Pa. Mr. Evans was formerly assistant general clerk in the rolling mill department.

T. Bruce Carpenter has joined Youngstown Sheet and Tube Co. as superintendent of the Brier Hill open hearth department. Mr. Carpenter succeeds **H. R. Ryan** who recently was appointed superintendent of the company's open hearth department at the Campbell, Ohio, works.

Albert H. Clem has been appointed to the newly created position of assistant to the vice president in charge of sales of the Pennsylvania Salt Manufacturing Co., Philadelphia, Pa. Mr. Clem was formerly assistant manager of sales in Pennsalt's special chemicals department. In his new position he will handle special assignments for the vice president.

James P. Kinney, former partner in Gordon & Kinney, Inc., Detroit, was appointed general sales manager, Philadelphia division, Yale & Towne Manufacturing Co. He succeeds **Samuel W. Gibbs,** resigned. Other appointments in that division include: **James A. Shellenberger,** formerly assistant to vice president-marketing, General Foods Corp., appointed director of advertising, publicity and market research. **John T. McCarley,** with Yale & Towne since 1936 in various engineering and factory management capacities, appointed manager of production, a new post, to direct production control functions for all product lines. **C. Eugene Moore,** formerly assistant to plant manager of the Electro-Motive Division, General Motors Corp., in Chicago, appointed works manager, a new post responsible for all manufacturing operations and maintenance of plant and equipment. **Bruno A. Moski,** formerly resident field engineer in the Philadelphia division representing the George H. Elliott Co., consulting engineering firm, appointed chief industrial engineer, a new post responsible for all plant industrial engineering functions. The company also announces retirement of **Ellis H. Jones,** as general manager, Canadian division, after 57 years of service, and appointment of **George L. Dirks** to succeed Mr. Jones.

John G. McLain was appointed to the roll sales engineering staff of Continental Foundry and Machine Co., East Chicago, Ind. Mr. McLain moved to Continental from a roll sales position at Lewis Foundry and Machine Co. He had formerly held positions in the operating departments at Bethlehem steel Co. and Jones and Laughlin Steel Corp.

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- Bloom-Paulsen-Steinbart Blast Furnace Gas Burner for Stoves and Boilers
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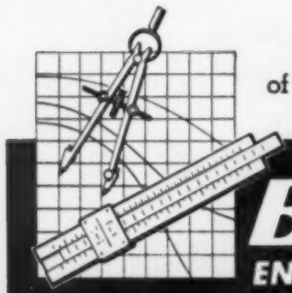

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Husky 10-ton mill type trolley equipped with separate load girt for easy removal.

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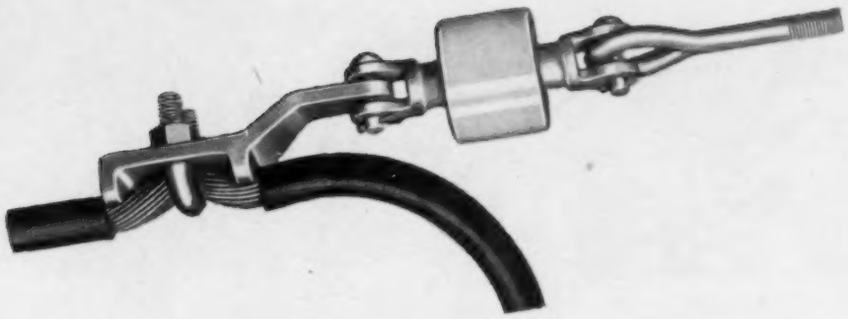
Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

"DEAD-END" YOUR FEEDER CABLE SIMPLY · · · SAFELY · · · SECURELY!



Positive insulation — superior strength . . .

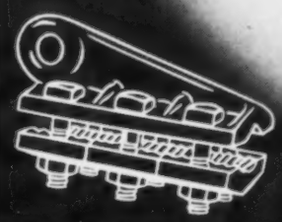
For over thirty years, industry has been choosing Keystone clamps and insulators to dead-end heavy feeder cables.

Cables just don't pull free from Keystone clamps—abundant bearing surface and sturdy construction insure a permanent installation. Sound design makes these clamps easy to attach, easy to tighten, easy to tape.

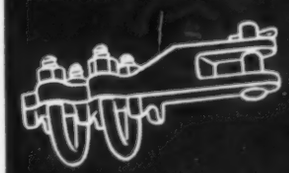
You'll find that Keystone Giant Strain Insulators will prevent current leakage, short circuiting and flash-over, even under adverse operating conditions. They're available in mica or porcelain, in all sizes and with a variety of fittings.

If you want positive clamping, high tensile strength and dependable insulation, you want Keystone cable clamps and insulators. For more detailed information, send for our new booklet on Industrial Feeder and Traveling Electrical Contact Material.

Typical application of Type "P" clamp, using No. 61349 Porcelain Covered Strain Insulator.



TYPE S-6 KEYSTONE Cable Strain Clamp. Similar to S-4, above, but with 6 bolts and separate clamping portions for heavy duty.



TYPE PD KEYSTONE Cable Strain Clamp. Two forged U-bolts provide increased cable grip where high strain is encountered. Bronze U-bolts for AC service.

TYPE S-4 KEYSTONE Cable Strain Clamp. Internally corrugated to assure firm grip on cable. Bronze lower half furnished for AC service.

TYPE HW KEYSTONE Cable Strain Clamp with Insulator. Insulation is cut away from cable at clamping point. Keeps strain in direct line with center of cable.

ELECTRIC SERVICE MANUFACTURING CO.

1721 CAMBRIA STREET • PHILADELPHIA 32, PENNA.

MAKERS OF CONTACT RAIL AND WIRE SUPPORTS, AND COLLECTION DEVICES

William H. Morse has been appointed manager of the a-c mechanical engineering section in the transportation and generator division of the Westinghouse Electric Corp. at East Pittsburgh, Pa. Mr. Morse succeeds the late A. C. Larson.

T. M. Evans president of H. K. Porter Co., Inc., Pittsburgh, Pa., was elected president of Connors Steel Co., Inc. Mr. Evans is also president of Quaker Rubber Corp., Philadelphia, Pa., president of American District Steam Co., North Tonawanda, N. Y., and chairman of the board of Southern Pacific Milling Co., Santa Barbara, Calif.

T. M. EVANS

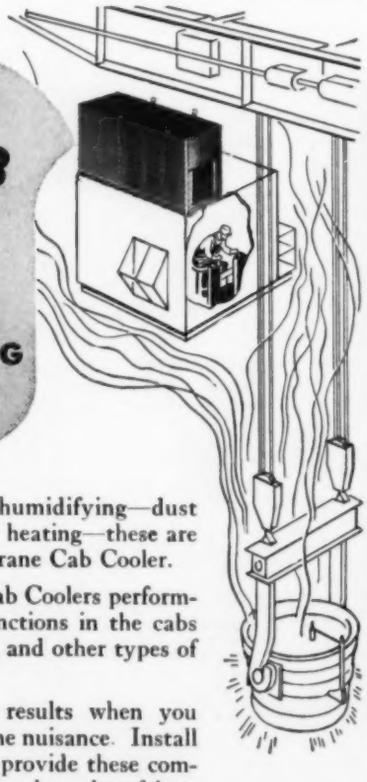
C. R. Dobson, executive vice president of H. K. Porter Co., Inc., Pittsburgh, Pa., was elected vice president and chairman of the executive committee of Connors Steel Co., Inc. Mr. Dobson, who is also vice president of Quaker Rubber Corp., Philadelphia, Pa., was chief industrial engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa., prior to entering the Porter organization in 1946.

C. R. DOBSON

Richard H. DeMott, who started as a salesman with SKF Industries, Inc., 35 years ago, has been elected president of the ball and roller bearing company. Mr. DeMott succeeds **William L. Batt,** wartime production

DRAVO CRANE CAB COOLERS

PERFORM EVERY AIR CONDITIONING FUNCTION



Cooling—fume removal—dehumidifying—dust filtering—ventilating—winter heating—these are the functions of the Dravo Crane Cab Cooler.

You will find Dravo Crane Cab Coolers performing these air conditioning functions in the cabs of soaking pit, ladle, stripper, and other types of hot-metal cranes.

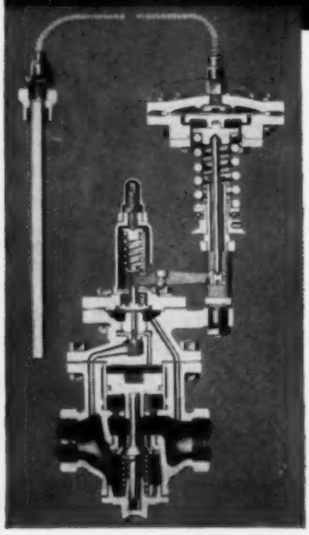
And you will observe real results when you eliminate heat fatigue and fume nuisance. Install Dravo Crane Cab Coolers to provide these comfortable working conditions in the cabs of hot-metal cranes.

DRAVO CORPORATION

PITTSBURGH · PHILADELPHIA · CLEVELAND · NEW YORK
CHICAGO · DETROIT · ATLANTA · BOSTON
Sales Representatives in Principal Cities

DRAVO

Here's Accurate Temperature Control



This LESLIE Temperature Regulator, Class LTCO, is actually a Pressure Reducing Valve actuated by a thermostatic element.

Install the bulb in the fluid being heated and small temperature changes will actuate the vapor pressure type element automatically, changing the setting of the regulating valve, and the outlet steam pressure.

The maximum outlet steam pressure delivered by the regulator is adjustable from 10 psi. to within 15 psi. of inlet pressure.

A typical installation on a fuel oil heater controls oil temperature within one or two degrees under maximum fluctuations of demand.

Write for Bulletin 464 for the complete story.

Lowest Overall Cost per Operating Year

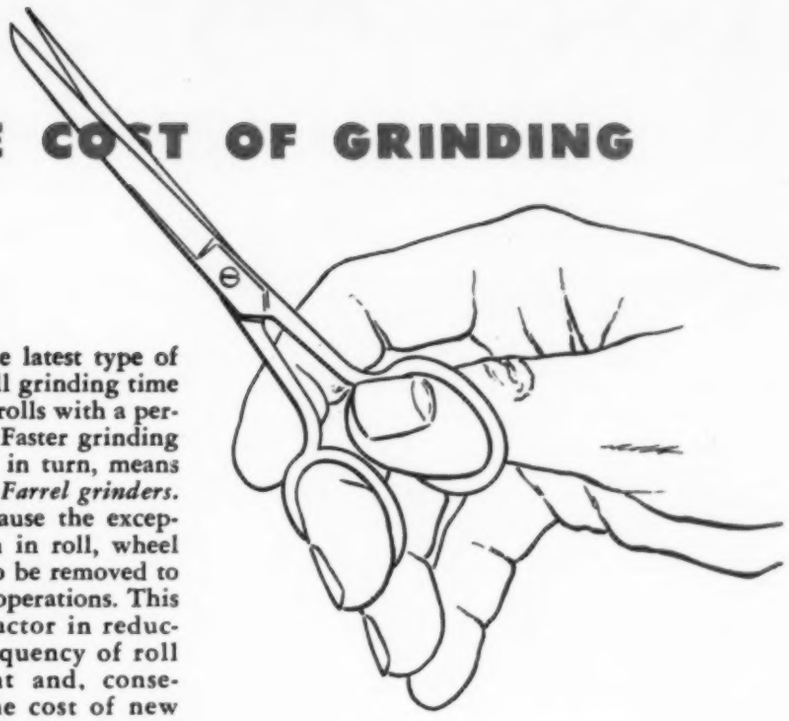
ESTABLISHED 1900 LESLIE CO. FIFTIETH ANNIVERSARY

LESLIE CO.

247 Grant Ave., Lyndhurst, New Jersey

PRESSURE REDUCING VALVES • • PRESSURE CONTROLLERS
PUMP GOVERNORS • • • TEMPERATURE REGULATORS
SELF CLEANING STRAINERS • • LESLIE-TYFON WHISTLES

YOU CUT THE COST OF GRINDING



Reports from users indicate that with the latest type of Farrel machines they are able to reduce roll grinding time substantially, and at the same time obtain rolls with a perfect surface free from marks of any kind. Faster grinding means less labor per roll ground, which, in turn, means *you cut the cost of grinding when you use Farrel grinders.*

In addition, your rolls last longer because the exceptionally smooth and vibration-free action in roll, wheel and traverse drives means less metal has to be removed to clean up a roll in roughing and finishing operations. This is a vital factor in reducing the frequency of roll replacement and, consequently, the cost of new rolls. While the amount saved varies with individual conditions, it represents, in any case, an appreciable return on the investment in a Farrel grinder.

Write for Bulletin No. 115 which describes this *cost-saving* machine in detail. A copy of this 28-page bulletin will be sent to you without cost or obligation.

when you use Farrel Roll Grinders

FARREL ROLLING MILL MACHINERY

Rolls • Rolling Mills • Rod Mill Tables and Manipulating Equipment • Universal Mill Spindles • Rod Coilers • Gears • Mill Pinions • Pinion Stands • Gear Drives of Any Capacity • Flexible Couplings • Roll Grinding Machines • Roll Calipers • Lead Presses for Pipe or Rod

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT
Plants: Ansonia and Derby, Conn., Buffalo, N.Y.
Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Chicago, Los Angeles, Houston

Farrel-Birmingham®

LINTERN
AIRE-RECTIFIERS
Proven By Performance
Used By Leaders

Here is a partial list of users of Lintern Aire-Rectifiers. Several companies have up to twenty Aire-Rectifiers in a single plant.
We value highly the confidence thus expressed in our product.

Allegheny-Ludlum Steel Corporation
Aluminum Company of America
Tennessee, Texas, and Davenport, Iowa, Plants
American Steel & Wire Company
Andrews Steel Corporation
Atlantic Steel Company
Atlas Steels, Limited
Bethlehem Steel Corporation
Bethlehem, Lackawanna, Steelton, and Sparrows Point
Birmingham Slag Company
Canadian Carborundum Company
Carnegie-Illinois Steel Corporation
Gary, South, and MacDonald Works
Colorado Fuel and Iron Company
Columbia Steel Corporation
Electro-Metallurgical Company
Ford Motor Company
Detroit and Candian Plants
Geneva Steel Corporation
Great Lakes Steel Corporation
Inland Steel Company
Jones and Laughlin Steel Corporation
Kennecott Copper Company
Keystone Steel and Wire Company
Laclede Steel Company
McClouth Steel Corporation
National Tube Company
Lorain and McKeesport Works
Northwestern Steel and Wire Company
Pittsburgh Metallurgical Company
Reynolds Alloy Corporation
Republic Steel Corporation
Cleveland
Rotary Steel Company
Southern Acid and Sulphur Company
Stanley Works, American Tube and Stamping Plant
Timken Roller Bearing Company
U. S. Navy
Weirton Steel Company
Westinghouse Electric Company
West Virginia Pulp & Paper Company
Wheeling Steel Company
Wisconsin Steel Company
Youngstown Sheet and Tube Company
Indiana Harbor

Lintern Aire-Rectifiers have been installed also on cranes for England, France, South Africa, and Chile.

SUCH *Preference* MUST BE MERITED

ASK FOR NEW BULLETIN 4912

THE LINTERN CORPORATION
54 LINCOLN AVENUE · BEREA, OHIO

expert, who formally resigned to re-enter government service as chief of the Economic Cooperation Administration mission to the United Kingdom. Both assumed their new duties November 1. Mr. DeMott, who has been vice president in charge of sales since 1943, played an important part in pioneering the use of antifriction bearings.

Rear Admiral Paul L. Mather, U.S.N. (retired), has

PAUL L. MATHER

become associated with the De Laval Separator as manager of its precision equipment division, and special assistant to the president, **George C. Stoddard.** In this position Admiral Mather brings to De Laval Separator a wealth of experience gained during the many phases of his career as a naval officer and government official.

Obituaries

Edwin G. Smith, 47, well-known engineer of Amsler Morton Corp., died October 24 following a prolonged illness. Mr. Smith had been associated with Amsler Morton since 1936.

H. H. Robertson, 72, chairman of the board of H. H. Robertson Co., died September 20.

Dr. John Johnston, 69, formerly director of research for U. S. Steel Corp., died September 12.

Julius S. Holl, advertising manager of Link-Belt Co., Chicago, Ill., for almost 40 years died October 24, after a prolonged illness.

Joseph A. Horne, 82, chairman of the board of directors of Yale & Towne Manufacturing Co., died October 3.

Earle S. Henningsen, retiring manager of engineering of General Electric's large motor and generator divisions at Schenectady, N. Y., died September 23.

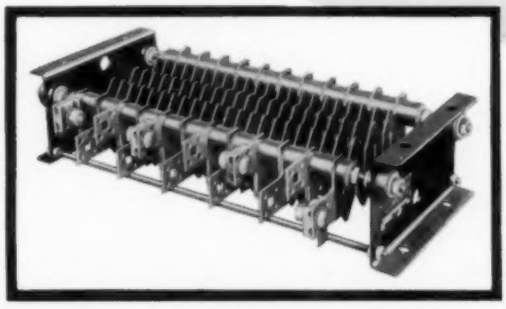
Dr. Robert Ernest Doherty, 65, who retired from the Carnegie Institute of Technology presidency in July, 1950, died October 19 in Scotia, N. Y.

William R. Reid, 71, chairman of the board of Torrington Co., died September 16 at Torrington, Conn., following a short illness. Mr. Reid had been with the Torrington Company for 50 years, 22 of which he had served as president. For the past four years he had been chairman of the board.

Save on Up-keep

with

TRADE MARK
EC&M TAB WELD PLATE RESISTOR
PATENT NO. 2,115,231



NO BURNING AT GRID-EYES OR TAP-PLATES

NO TIGHTENING OF END CLAMPING NUTS

Here's a *PLUS VALUE* in resistors—more time for the maintenance crew to inspect, check, adjust and maintain other units of the motor drive . . . no need to fear burning will occur in concealed areas. EC&M TAB-WELD Plate Resistors will quickly pay for themselves through reduced upkeep expense.

Look at the view above showing a standard section from which the support rods and spacers are removed. *The electrical path remains unbroken.* These EC&M TAB-WELD Plate Resistor sections are available in continuous capacity ratings from 32 to 150 amperes *without internal* paralleling. When desired, *external* paralleling is easy where larger capacities are desired. Remember, too, there are only 9 different grid sizes for the entire 32-150 ampere range.

ALSO IMPORTANT—

1. Negligible change in resistance values between hot and cold.
2. Corrosion resistant, non-breakable alloy steel.
3. Closely spaced, convenient tap-plates.
4. Uniform mounting dimensions.
5. Standard Mill Sections have same size grid throughout.

Make your own layouts with EC&M Bulletin 942-A TAB-WELD Plate Resistors

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

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Republic Steel Corp.
Steel and Tubes Division
Cleveland, Ohio

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Electrical Superintendent
Compania de Acero del Pacifico
Talcahuano, Chile, South America

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EMIL A. VIEROW
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Youngstown District
Youngstown Sheet & Tube Co.
Youngstown, Ohio

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Steel Works Division
Metallurgical Department
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Pittsburgh, Pa.

R. M. WILLIAMS
Works Industrial Engineer
Aliquippa Works
Jones & Laughlin Steel Corp.
Aliquippa, Pa.

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Engineer of Heavy Mills Department
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Sydney, Nova Scotia, Canada

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Chief Industrial Hygiene Engineer
Bethlehem Steel Co.
Bethlehem, Pa.

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Mechanical Department
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Edgar Thomson Works
Carnegie-Illinois Steel Corp.
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EDLORE DeMAY
Roller
Great Lakes Steel Corp.
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National Tube Co.
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Vice President Operations
Armco Steel Corp.
Middletown, Ohio

RAOUL FERRERI
Representing Italian Steel Group
Finsider Secuta Finanziaria Sideringica
Rome, Italy

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Materials Handling Engineer
Iron & Steel Operations
Ford Motor Co.
Dearborn, Mich.

ARTHUR A. HAINES
Division Fuel Supervisor
Lukens Steel Co.
Coatesville, Pa.

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Wheeling Steel Corp.
Steubenville, Ohio

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Crucible Steel Co. of America
Midland, Pa.

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Foreman
Electrically Welded Fabric & Nail Mill
Colorado Fuel & Iron Corp.
Buffalo, N. Y.

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Steam Efficiency & Combustion Department
Jones & Laughlin Steel Corp.
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Dominion Steel & Coal Corp., Ltd.
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Superintendent of Maintenance
Plate, Sheet & Tin Mill
Compania de Acero del Pacifico
Talcahuano, Chile, S. A.

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Assistant Electrical Engineer
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Sparrows Point, Md.

R. L. SEAY
Steel Erector Foreman
Sparrows Point Plant
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Braeburn, Pa.

Associate

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Executive Vice President
(Technischer Direktor)
Siemag Vertriebsgesellschaft M.B.H.
Dahlbruch/Westfalen, Germany

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Pittsburgh, Pa.

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Detroit, Mich.

RALPH A. CLARK
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Union Carbide & Carbon Corp.
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Salesman
Graybar Electric Co., Inc.
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RAY W. COVER
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W. H. DAUBERMAN
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Cleveland, Ohio

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The Trumbull Bronze Co.
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District Manager
The Torrington Co.
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TED WHITE
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DANA K. ABBOTT
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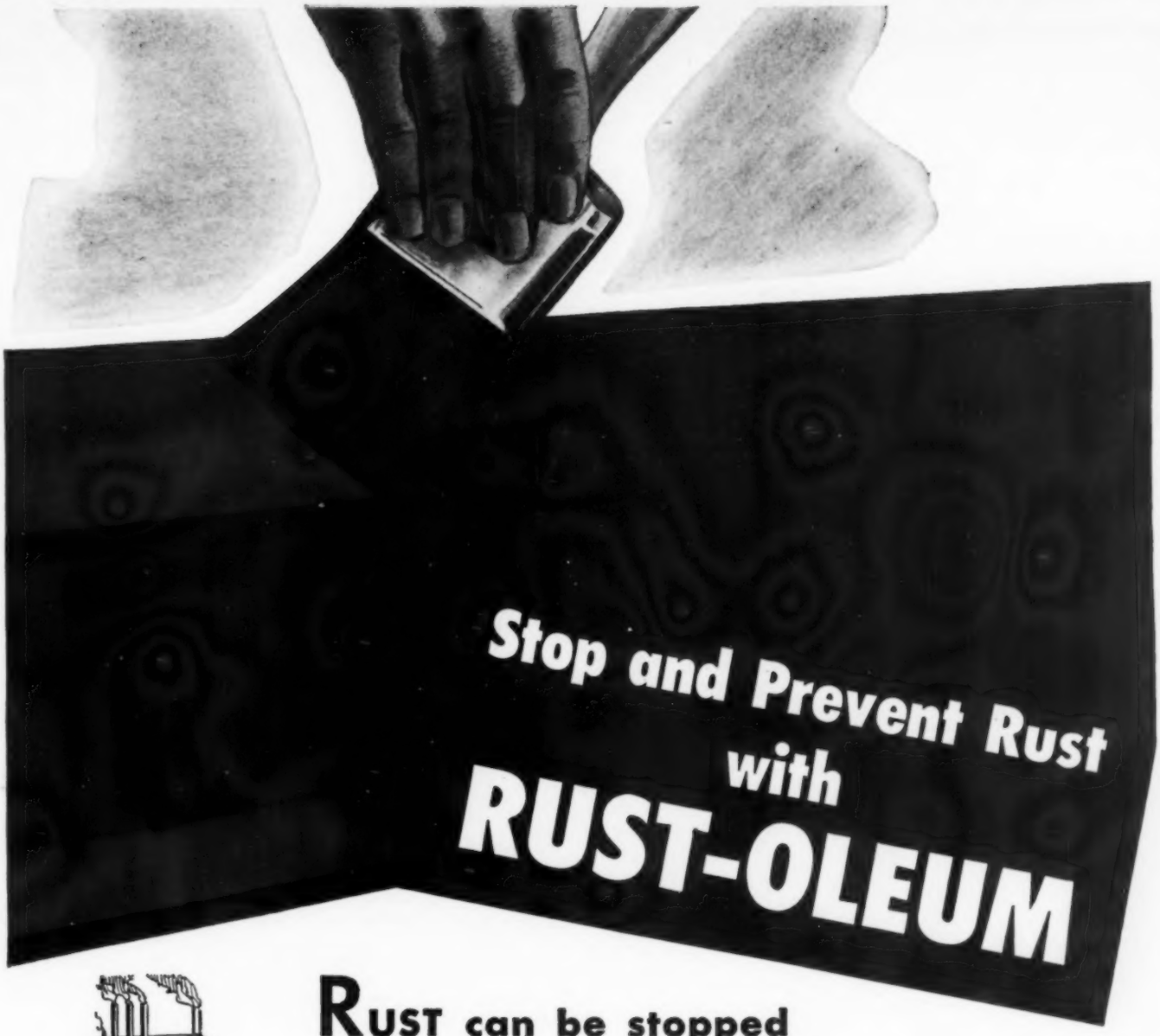
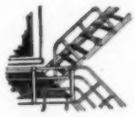
Allentown, Pa.





RUST can be stopped

. . . stopped easily, surely, economically!

RUST-OLEUM is the answer. For 25 years it has proved its capacity to stop and prevent rust at sea, in fume-choked industrial areas, on railroad rolling stock, bridges and signaling equipment.

RUST-OLEUM . . . an exclusive formula . . . protects metal with a tough, long-lasting pliable film that dries to a hard, firm finish that defies rain, snow, salt air, fumes and weathering. It adds years of extra use to metal roofs, tanks, sash, fences, stacks, gutters, downspouts, machinery and other metal surfaces.

RUST-OLEUM decorates as well as protects. It is available in all colors, aluminum and white. It can be applied to metal where rust has already started. You don't have to remove all the rust.

RUST-OLEUM is stocked and sold by Industrial Distributors in most principal cities. See our complete catalog in Sweets, or write for full information.

RUST-OLEUM CORPORATION

2441 Oakton Street, Evanston, Illinois

Integrator

Indicator-Recorder-Integrator

Varying flows are accurately totalized because the integrator is continuous

The Republic flow integrator, being of the modified watt-hour type, totalizes continuously—not intermittently. It operates independently of the recorder and its accuracy is not dependent on or affected by any clock mechanism or mechanical action.

The Republic meter is, on this account, peculiarly fitted to follow all changes in flow rate and accurately measure highly fluctuating flows.

ALL TYPES OF FLUIDS

Republic electric type flow meters are available for measuring the flow of all types of liquids and gases. Meter bodies are built for metering fluids at line pressures up to 5,000 lb. per sq. in. and for all ranges of differential pressure. The reading instruments—indicator, recorder and integrator—are of the remote reading type and can be located any distance from the point of flow measurement.

ANY COMBINATION

While each Republic reading instrument is standard in design and construction each is especially calibrated for the particular flow measurement for which it is specified. Any reading instrument, indicator, recorder or integrator, may be obtained separately or in any combination desired, making possible the highest degree of flexibility in plant use.

SIMPLE IN OPERATION

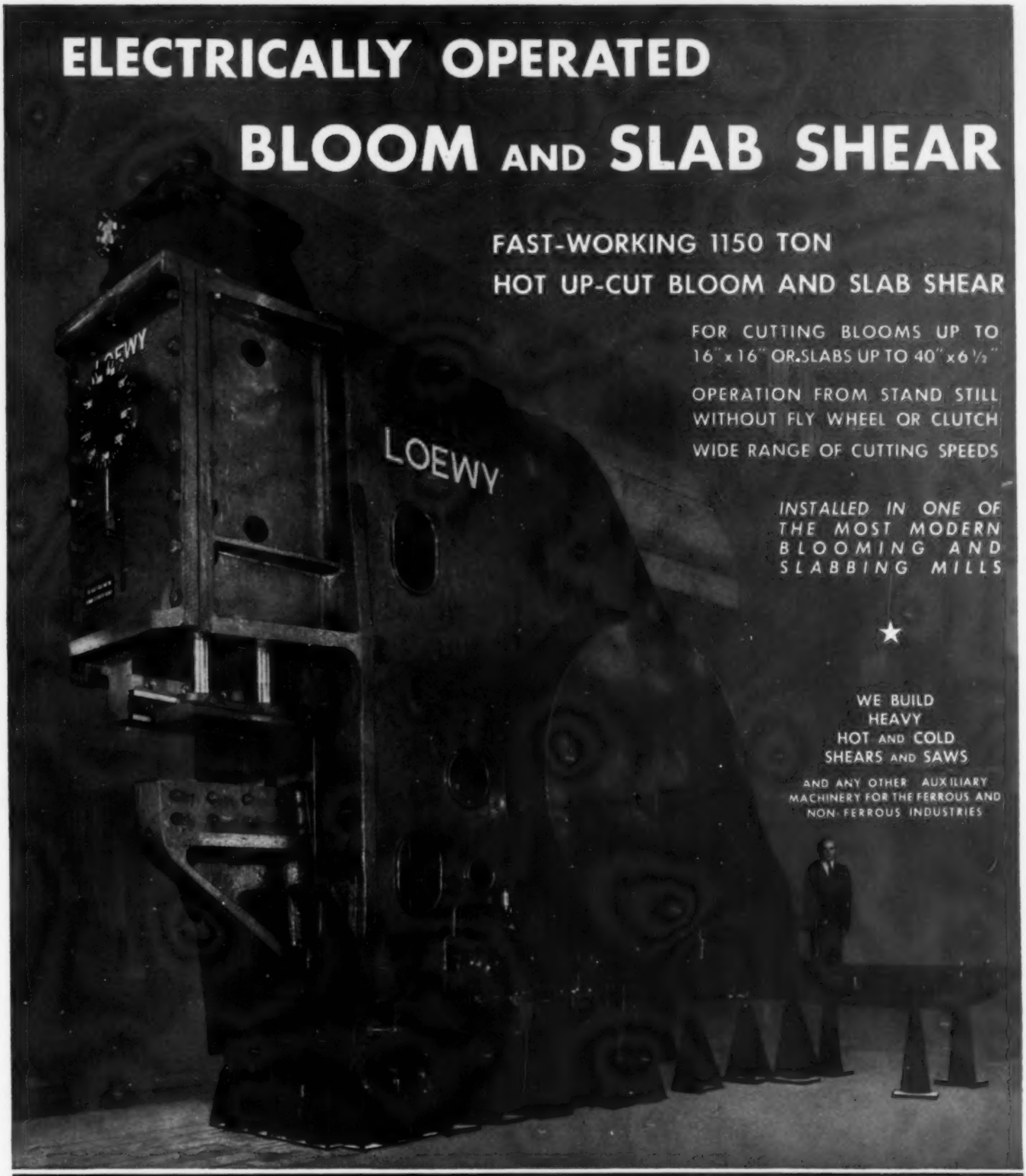
The Republic electric meter is the only flow meter commercially manufactured which is strictly electric in its operation. All other types of so called electric meters use the motion of the mercury to move a float or produce a force which is then converted into an electrical value which is in turn transmitted to a receiving or reading instrument. In the Republic meter, the transmitted electrical value is determined directly by the mercury motion, thus eliminating one of the steps in the sequence, and simplifying the mechanism to that extent. There are no floats, levers, cams, rotating shafts or anything else to interfere with the unimpeded movement of the mercury, which has no work to perform, but merely fulfills the function of making contact.

NEW DATA BOOK

Just off the press—a completely new data book describing and illustrating, in detail, the operating features of the Republic Flow Meter and its many applications. Write for your copy of Data Book No. 702—there is no obligation.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

ELECTRICALLY OPERATED
BLOOM AND SLAB SHEAR



FAST-WORKING 1150 TON
HOT UP-CUT BLOOM AND SLAB SHEAR

FOR CUTTING BLOOMS UP TO 16" x 16" OR SLABS UP TO 40" x 6½"

OPERATION FROM STAND STILL WITHOUT FLY WHEEL OR CLUTCH

WIDE RANGE OF CUTTING SPEEDS

INSTALLED IN ONE OF THE MOST MODERN BLOOMING AND SLABBING MILLS

★

WE BUILD
HEAVY
HOT AND COLD
SHEARS AND SAWS

AND ANY OTHER AUXILIARY MACHINERY FOR THE FERROUS AND NON-FERROUS INDUSTRIES

LOEWY ROLLING MILL DIVISION
HYDROPRESS · INC ·
ROLLING MILLS AND ROLLING MILL EQUIPMENT

566-568 LEXINGTON AVE. GENERAL ELECTRIC BUILDING AT 51st STREET NEW YORK 22

CHICAGO DETROIT SAN FRANCISCO SEATTLE WASHINGTON, D. C

15-TON SCARFING BUILDING CRANE

BUILT BY MORGAN Engineering

Illustrated is a Morgan 15-ton, 3-motor, 40′-0″ Span Half Gantry Type Scarfing Building Crane. Hoist is actuated through a worm reduction unit for operating a counterweighted hoist rack connected to two lifting magnets, for handling slabs.

THE MORGAN ENGINEERING CO.

ALLIANCE, OHIO PITTSBURGH—1420 OLIVER BUILDING

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

Equipment News...

CORROSION RESISTANT COATING PROTECTS SHEET STEEL BATTERY TRAYS

▲ For years battery research men sought a paint that would resist the action of the small amounts of acid which may accumulate outside storage batteries. At last the problem of steel battery tray corrosion has been solved.

Sheet steel battery trays were made available just before the war, because in many instances they proved superior to wood trays. For example, the greater strength of steel trays was important, particularly for larger industrial batteries, some of which weigh up to three tons. Furthermore, since steel isn't as bulky as wood, it permitted the use of larger batteries in the same space and provided a neater appearance. The greater strength of the steel trays also eliminated the need for special compartments to house battery installations in electric vehicles. Finally, steel trays were a step toward standardization of the space allotted to batteries and eliminated hand tailoring of wood trays to fit odd dimensions. The result was improved interchangeability and savings to the user. However, to capitalize on these advantages, it was necessary to find a corrosion resistant coating for the sheet steel. Asphalt-base paints, being porous, provided only limited resistance to corrosion. Also under rough usage they yielded too easily to abrasion.

During World War II, engineers of Electric Storage Battery Co., manufacturers of Exide "Ironclad" batteries, began developing a new corrosion proof process to protect aluminum alloy battery compartments in military airplanes. This process not only used a new type of corrosion resistant coating but also a new technique for applying it. Since the new coating protected corrosion sensitive aluminum alloy against the action of acid, experiments were tried on sheet steel coated with the paint. These proved successful, and a number of steel trays, in production for heavy duty motive power batteries, were treated with this process. After several years of use in the field, service reports indicated that this special coating was the answer to the corrosion problem.

The new coating highly resists corrosion, according to Exide Engineers. They also claim that if, under unusual circumstances, the surface is scraped exposing the bare steel, corrosion is limited to that area. This is due to the tight bond formed between the coating and the metal surface. As a result, corrosive action can't wedge its way between the two, but is confined to the damaged area.

The bond to the steel tray, as well as other qualities within the coating, are said to enable it to withstand mechanical abuse from blows and abrasion without flaking off. Tests indicate that the new coating holds even when the blow is heavy enough to dent the steel.

After two years service, this battery, on which the coating was used, does not show corrosion.

DEVELOP STRADDLE TRUCK FOR STEEL MILL USE

▲ An entirely new straddle carrier designed particularly for steel mills and industries having similar severe service conditions has been announced by Ross Carrier Co.

Designated Ross Series 100, this new carrier handles 45,000 lb loads, travels up to 33 mph forward or reverse. Full vision design gives unequalled road and load visibility and conforms with latest highway safety requirements.

The new carrier features a wide margin of reserve strength in every part. The frame has heavily reinforced and braced formed steel wide box-section side members and tubular upright and cross members, all electrically welded into a rugged unit. More than 35 years' experience in straddle carrier design and manufacture are combined in this superior straddle carrier frame.

It is powered by a heavy duty six cylinder 140 hp gasoline engine. The 14-in. single plate clutch is non-shock loading. Steering is four-wheel hydraulic.

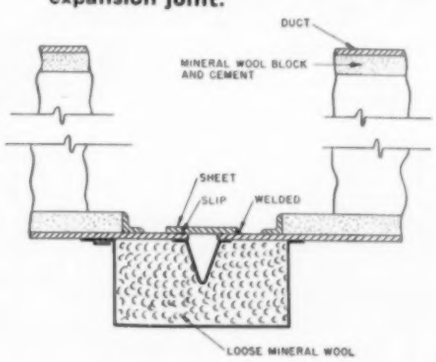
INSULATION TECHNIQUE FOR EXPANSION JOINTS

▲ Calculations made by insulation engineers of the Public Service Electric and Gas Co. of New Jersey indicate that expansion joints of ducting should be insulated. Otherwise, surrounding areas are overheated and Btu's are wasted with resultant higher fuel costs and decreased overall efficiency of the system.

To prevent heat loss at these vulnerable points, the utility has devised a simple technique which it is now using at its new 300,000 kw Sewaren plant.

This technique comprises the construction of a light-gage metal box over the joint as illustrated. One edge of the box is not firmly secured, allowing it to bend in or out as the

Technique comprises the construction of a light-gage metal box over the expansion joint.



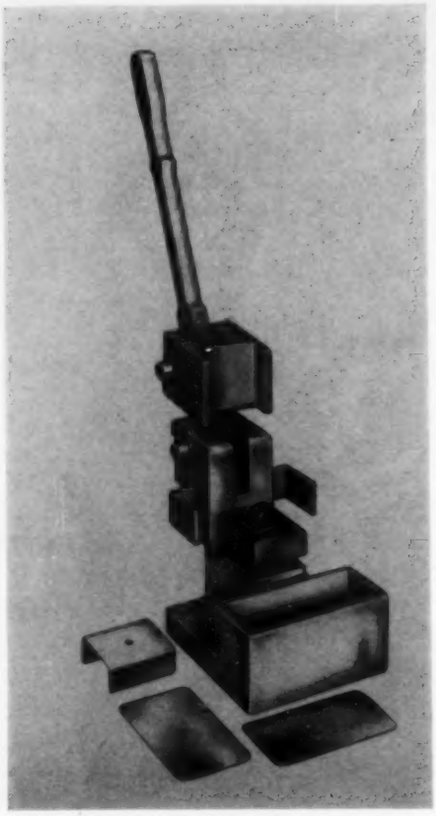
joint contracts or expands. The box is filled with loose mineral wool to prevent heat loss. Depth of the box depends on the temperature of the duct.

The utility insulates its ducts both internally and externally, depending on duct service, and applies this expansion-joint covering in both cases. The sectional drawing illustrates the joint-enclosure as applied to a duct internally insulated with mineral wool blocks. The box, of course, circumscribes the complete perimeter of the duct.

DEVICE BENDS TAGS USED FOR HEAT IDENTIFICATION

▲ A new device for bending metal tags used in the identification of heats in merchant bar mills has been developed by M. E. Cunningham Co. This new Model TO-1X tag bender bends the tags so they may be fit over a hammer with a nail in position for driving into the billet.

With this new tag bender a nail first is placed in position, then a 1 in. square tag with heat identification numbers, finally a 3½ in. x 2 in. metal tag. When the handle is depressed the nail is forced through both tags, and the larger tag is formed to fit over the nose of the tagging hammer. The ends of the large tag fit into special clips on the hammer which hold it in position while the hammer is swung.



The new bender bends tags so they may be fit over hammer with nail in position.

This identification system is used on the first and last billet of each heat as it enters the preparation furnace.

THERMOCOUPLE GAGE MEASURES VACUUM

▲ A redesigned line of thermocouple vacuum gages for industrial, laboratory and other applications where vacuum must be accurately measured has been announced by General Electric's meter and instrument divisions.

Included in the line are a 115-volt, a-c, portable thermocouple vacuum gage, and types for both rack and panel mounting. All but the rack-mounted type have been designed to operate either from 115-volt a-c

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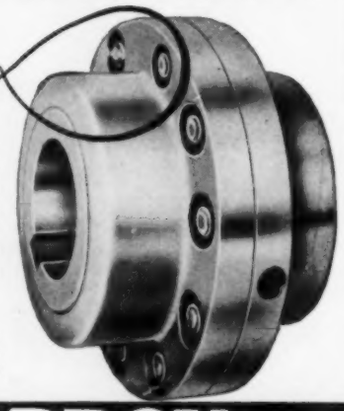

The Waldron cover sleeve is one solid forged steel piece with no welding to distort the accurate gear inside. This feature not only prevents possible trouble but also permits operation at highest speeds.

For details on other construction and operating advantages — ratings service factors, etc. — ask for Catalog 57.

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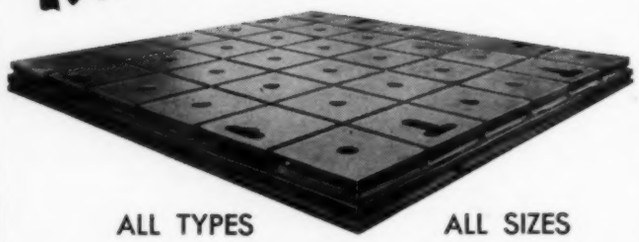

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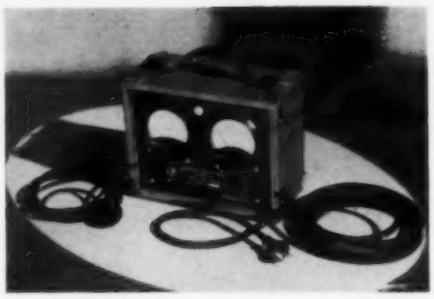


Gages give a continuous indication of pressure with instantaneous response to pressure change.

or from No. 2 flashlight batteries.

Usable on either glass or metal vacuum systems, the gages give a continuous indication of pressure and respond almost instantly to pressure changes. Pressure can be read directly from a scale calibrated from 0-200 microns.

In the 1-100 micron range, the instruments are accurate within 10 per cent of the reading or 1 micron, whichever is greater.

The gage is connected to the gage tube electrically; hence it may be disconnected from the tube without disturbing the vacuum system. The gage tube may be interchanged without the need for recalibrating the indicating instruments.

The vacuum-gage tube is built to withstand damage if accidentally operated at atmospheric pressure.

UNIT AUTOMATICALLY COMPUTES CIRCUITS

▲ Hagan Corp., is announcing the "Hagan Ratio Totalizer," which is designed to receive several control signals or pressures and to produce a single output loading pressure in any desired ratio to the incoming loads.

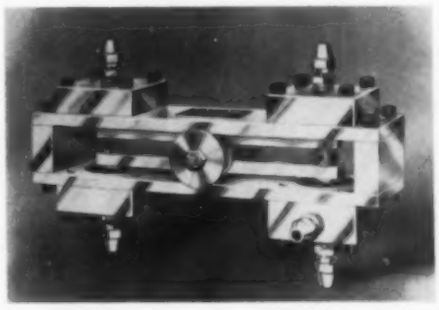
It is pneumatically operated and can accommodate as many as three input loading pressures plus three spring forces in a single unit.

The new unit is designed for use in computing circuits for such functions as addition, subtraction, multiplication, and division of control signals, and in control circuits for introducing proportional band action, rate action or automatic reset, either separately or in any desired combination.

The standard assembly consists of a bar stock steel frame with nonmetallic flexible diaphragm elements in each of four chambers. An adjustable fulcrum allows broad adjustment of output loading pressure, which may be in the ranges of 3-15 lb, 0-30 lb or 0-60 lb.

Any input pressure chamber may be fitted with an adjustable tension spring with a maximum tension equivalent of up to 60 psi loading pressure. Bellows-type pressure elements, which are interchangeable for use with pressures above 60 psi,

Computer can be used to introduce proportional band action, rate action or automatic reset, either separately or in combination.



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FREE Write to Oakite Products, Inc., 19 Thames St., New York 6, N. Y., for Folder F7642. This 8-page illustrated leaflet describes 19 advantages of the OAKITE CrysCoat PROCESS and lists 10 ways in which it cuts the cost of cleaning and preparing for painting.

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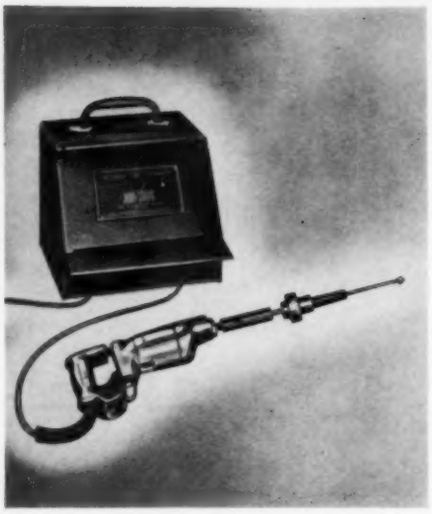
may be fitted to any of the input chambers.

Hagan engineers who have conducted field test applications report that it has been successfully applied in general process control, central station and industrial power plant regulation, aeronautical laboratory testing and in other fields which demand sensitivity, accuracy, and durable service.

TUBE ROLLING CONTROL IS GREATLY SIMPLIFIED

▲ Announcement of a new, and greatly simplified tube rolling control has just been made by the Crane Packing Co. This new, electrically operated control is low in initial cost, and because of the elimination of electronic tubes and large numbers of working parts, it practically does away with maintenance. It can be used for rolling of both ferrous and non-ferrous tubing.

The unit is a precision instrument designed for heavy duty service. It has only two electrical working parts, shockproof mounted and enclosed in



Only two electrical parts are used in this new tube rolling control.

a rugged aluminum cabinet. The electrical parts form a separate, easily-removed unit which can be readily replaced when necessary without special electrical skills. The entire control unit is light in weight, and is easily moved on the job. Absence of a voltage regulator adds to the mobility.

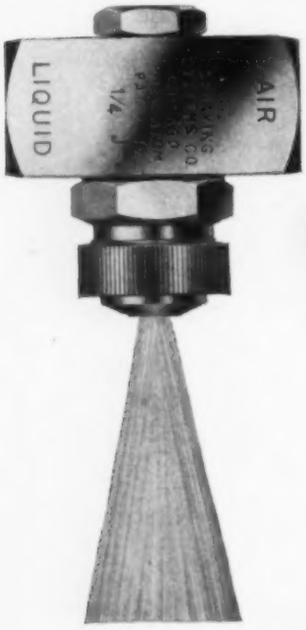
Outstanding advantages of the control, over other controlled tube rolling methods are: only two electrical working parts; no electronic tubes; light weight and absence of voltage regulator; automatic alignment; elimination of maintenance.

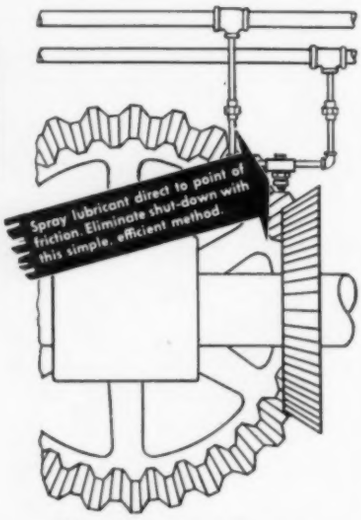
MICROSCOPIC OIL SPRAY LUBRICATES BEARINGS

▲ Alemite "Oil Mist," a system of constant and automatic delivery of lubricating oil to all types of machine bearings in "air-borne" microscopic particles through tubing, has been announced by the Alemite division of Stewart-Warner Corp.

Virtual elimination of the human factor in lubrication, drastic economy in lubricant consumption and prolonged bearing life are high spots among the claims for the new system over other lubrication methods. In addition, reduction of bearing temperatures, permitting stepped-up machine speeds; prevention of product spoilage by complete elimination of drippage and, elimination of machine down-time for lubrication are claimed for the system.

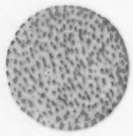
Lubrication of each bearing is ac-





direct-to-gear lubrication with SPRAY NOZZLES

Spraying Systems Pneumatic Atomizing Nozzles provide efficient, low cost lubrication for gears or other moving parts. Lubricant materials from very light oils to greases may be successfully sprayed. Advantages of this method are that lubricant is applied where required without need of shut-down . . . and the system does not have to be an in-built part of the machine.



Write for Data Sheet 4516 and complete information on Spraying Systems Spray Nozzles for steel mill application.

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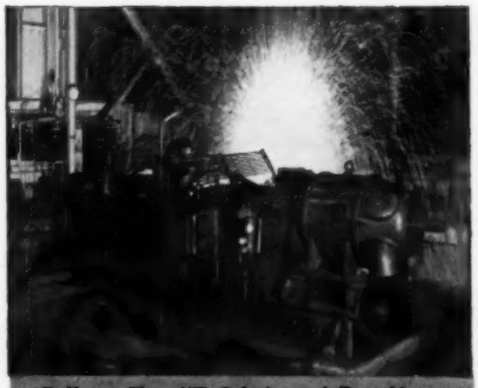
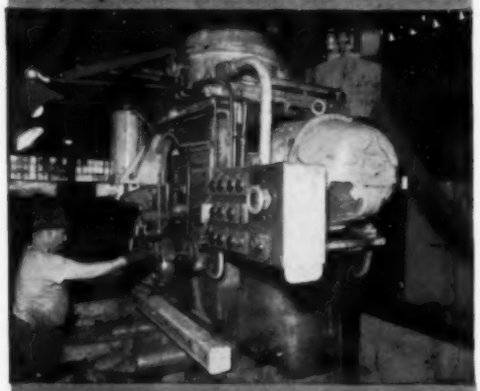


Reliance Type 'T' Splash-proof D-c. Motors provide dependable power for skelp levellers in modern tube mills.

On continuous miners, specially designed Reliance Type 'T' D-c. Motors provide greater horsepower in the limited space available than ever before attained.



Power for chipper of Billeteer is provided by motor which is subject to recurring shock overloads. Protection and capacity, without excess weight, are obtained by use of force-ventilated Reliance Type 'T' D-c. Motor.

RELIANCE *TYPE 'T'* HEAVY DUTY D-C. MOTORS

Wherever motors must meet rugged service requirements, Reliance Type 'T' Heavy Duty D-c. Motors are right in their element! Designed, engineered and constantly improved to satisfy the requirements specified by users, these dependable motors have proved their amazing endurance in steel mills, in underground mines and in countless other industrial applications.

All-steel frames give maximum strength. Other features: thorough insulation of armatures and field coils by Reli-X varnish treatment; extra-strong commutators to assure capacity for overloads of current and speed; cast bronze brush holders to provide and maintain accuracy for peak performance; precision bearing design . . . "you can't grease 'em wrong". Write today for *new* Bulletin C-2001 containing complete data on these rugged, heavy duty Type 'T' D-c. Motors available from 3/4 to 1000 horsepower for constant or adjustable speed.

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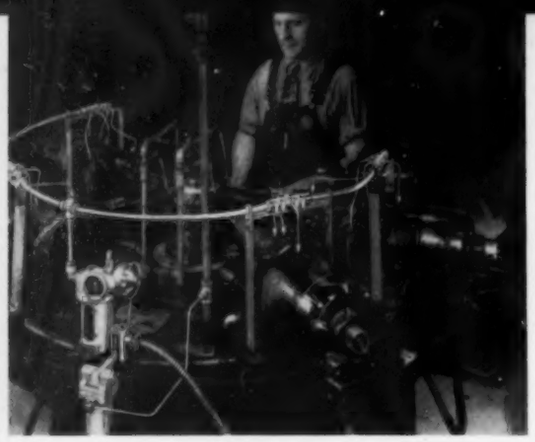


Virtual elimination of human element in lubrication is a feature of new oil spray system.

complished without measuring devices. "Lubrication cycles" are eliminated and maximum machine efficiency is realized. Delivery of oil is constant and automatic whenever a machine is in use, and the only volume determinant is the bearing requirement. A fresh, constantly replenished supply is present in the bearing so long as the machine is running.

Both coolant action and protection against dust and abrasives on bearing surfaces are provided. The cooling action arises from two conditions. One is application of just the right amount of oil, thus preventing "fluid friction." The second is the passage through the bearing of the air which delivers the mist. The pressure of the air carrying the mist is slightly greater than atmospheric pressure. Thus, dust, abrasives or other harmful matter in the atmosphere are kept from entering.

The lubricator, attached to each machine, is slightly smaller than the oil filter on a passenger automobile. In operation, there are no moving parts. Only two controls are used. One control is a built-in air pressure regulator. The second is a needle type valve which controls the flow of oil.

In operation of the lubricator, dry clean air must be used. Alemite has provided a new water separator, self-emptying, without interruption while in use, to assure dry, clean air for the Oil Mist system.

THORIATED TUNGSTEN USED IN ARC WELDING

▲ Thoriated tungsten, long used in electronic tubes because of its excellent electron emission characteristics, is now available as a non-consumable electrode (Thor-Tung) for "Heliwelding"—Airco's inert-gas-shielded arc welding process. This new electrode has proven extremely valuable in d-c straight polarity welding.

Actual tests have shown that thoriated tungsten operates much cooler than standard tungsten electrodes, thus permitting the use of higher currents on given size electrode. Further, it has excellent arc stability not only at these high currents, but also at currents lower than those possible with conventional tungsten electrodes.

Since it runs cooler and does not become molten, consumption is almost negligible and contamination resulting from accidental or deliberate touching is eliminated; touch-starting thus becomes a practical operation, even at low currents.

Because of its permanency, Thor-Tung may be "pointed" to permit continued operation at extremely low currents. This new d-c straight polarity method of aluminum, using these new electrodes and helium as a shielding gas, not only eliminates the special problems heretofore encountered in a-c "Heliwelding," but also provides a hotter, more stable and more efficient arc which produces deeper penetration and faster welding with lower gas consumption per foot of weld and less distortion; special plate edge preparation is simplified or eliminated.

ROTARY STRAIGHTENER SAVES PRODUCTION TIME

▲ Lost production time has been minimized at Greenville Tubes, Inc., Greenville, Pa. since the installation of this new rotary straightener. Positioned on the production line between final sizing and last cut-off, copper, stainless steel and inconel tubing flow from the Mackintosh-Hemphill straightener's runout table into the cut-off machines.

In an 8-hour shift, this rotary straightener does a precision job of straightening between 40,000 and 55,000 ft of tubing that ranges in size from $^{9}/_{32}$ in. to $^{1}/_{2}$ in. When inconel tubing is passed between its crossed rolls, the machine operates at $^{3}/_{4}$ rated speed, or at the rate of 125 fpm.

This type of production equipment has been advantageous for Greenville Tubes to use because set-up

The new straightener neither increases nor decreases OD and ID of tubing.

time for various sizes of tubing is very low, and down time for maintenance is negligible. Since installation, this straightener has required no maintenance except normal lubrication, checking and minor roll polishing by the operator.

In meeting the close tolerances required by customers, Greenville Tubes has found the straightening unit neither increases nor decreases OD and ID of tubing. In working the metal to remove stresses created by the final sizing, precision straightening is secured and a burnishing effect on the tubing is accomplished.

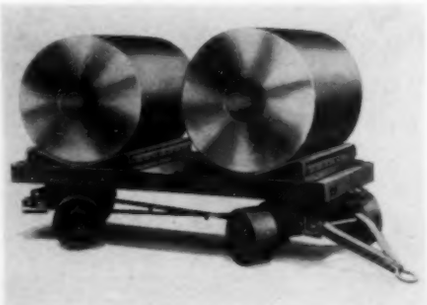
COILED STEEL TRAILER HAS 10-TON CAPACITY

▲ A 10-ton capacity trailer for transporting coiled strip steel has been developed by Phillips Mine & Mill Supply Co.

Designed for carrying two coils of strip 48 in. in diameter, this tractor-drawn trailer is arranged so the strip will ride in tandem on "V" blocks. A rubber covering on the blocks protects the steel against damage.

A wide wheel base and low center of gravity eliminate danger of tipping over. The bed height is 24 in., width 26 in. and overall body length 102 in. The trailer is equipped with solid rubber-tired wheels and Timken roller bearings.

Two coils of strip 48 in. in diameter can be carried on this trailer.



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NOVEMBER, 1950

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(1) Worm Gear Drives

Link-Belt worm gear drives of three basic types, each available in 10 different sizes, for fractional or large horsepower, and in speed ratios of 3⅝ to 1 up to 8000 to 1, are illustrated, described, tabulated in a new 80-page book just released. Features enumerated for these enclosed right-angle drives are — Compact design; anti-friction bearings; automatic splash lubrication; high ratios in small space; operation at high input speeds; quiet performance; and their availability for vertical or horizontal driving. (2324). Link-Belt Co.

(2) pH Electrode Catalog

A complete line of pH electrodes and assemblies for both industrial and laboratory applications is now presented for the first time in a new, 28-page catalog, "pH Electrodes, Assemblies, Parts and Accessories." This publication is designed to help present users of L&N pH equipment in ordering replacement parts and to guide new or prospective users in selecting the proper electrodes to solve their pH problems. It lists the advantages of each type of electrode, and by means of an illustrated, double-page spread, shows each assembly and all of its components in tabular form. Glass electrodes for industrial use are shown in detail, whether for use in plastic, Pyrex or iron assemblies; glass electrodes for laboratory use are illustrated with their appropriate measuring instruments. Other L&N laboratory electrodes — hydrogen, quinhydrone, oxidation-reduction — are listed with their reference electrodes. (EN-S5). Leeds & Northrup Co.

(3) Refractory Hung Arch

A bulletin is available describing how a refractory hung arch not only hangs — but moves — like a pendulum. The bulletin describes the ease of installation and the positive locking arrangement between the lower and the upper tiles, preventing disengagement in service. It also illustrates the rugged load tests given the double hung arch, not only the load-bearing qualities of the arch but also the strength of the interlock. (950). Geo. P. Reintjes Co.

(4) Combustion Control

A bulletin, entitled "Combustion Control for Industry," is available to you. The bulletin, which describes the new Cities Service "Heat Prover," supplies facts that will show you whether your plant is wasting furnace fuel, whether excess (scale-making) oxygen is present, and whether you are paying needlessly to heat excess air. This exclusive flue gas analyzer strictly checks combustion factors. Then sources of loss can be traced and corrected. Operators of all types of furnaces report they have been able to clamp down on cost and step up production, simply by using the Cities Service Heat Prover. Find out how easily you can arrange to put it on the job. Cities Service Oil Co.

(5) Thermocouple Manual

A new 42-page 1950 edition of the Wheelco "Data Book and Catalog" containing up to date prices, application recommendations and pertinent information concerning instrument sensing units and associated accessories, has just been released. Among the many special items listed in the convenient table of contents are resistance bulbs and wells, radiation detector, special thermocouples for plastic injection and extrusion machines and a new molten metal thermocouple for ferrous metals. (TC-8). Wheelco Instruments Co.

(6) Ratio Totalizer

Twelve suggested applications of the Hagan "Ratio Totalizer" in automatic control circuits are described and illustrated by diagrams in a new bulletin now available. The "Totalizer" is a pneumatically operated control mechanism for accurately combining input control pressures and spring forces to produce a single output control pressure. Applications in computing circuits include addition, subtraction, multiplication and division, averaging, and reversal of loading pressure. For regulation and control action, the unit can be used to obtain a proportional band action, with automatic reset if required, a rate action, or a combination of proportional band plus automatic reset plus rate action. Some specialized applications include selector action, pressure splitting, and pneumatic toggle switching. The bulletin points out that the applications illustrated represent only a fraction of the arrangements possible when using the unit either singly or in multiple. A cutaway drawing in color illustrates the principles of operation and other drawings illustrate modifications of the basic design for special uses. (5450). Hagan Corp.

(7) Motoreducer

Just released is a new bulletin illustrating and describing the new all-steel right angle "Motoreducer" which combines the advantages of a standard "Motoreducer" with the adaptable right angle head. This reducer can be used for either horizontal or vertical applications and is available with output shaft single or double ended. The all-steel construction guarantees greater rigidity, strength and motor adaptability. (3110). Falk Corp.

(8) Rotary Retort Atmosphere Furnaces

One of the newest tools available to the production heat treater, the rotary retort controlled atmosphere furnace, is described in a new, attractive bulletin just issued. These furnaces which have aroused considerable interest in production line heat treating are presented in considerable detail with diagrams illustrating typical production line operation. One of the most significant features of these furnaces is the fact that they permit fully auto-

matic operation of the work feeding and processing system. These furnaces are used for gas case carburizing, homogeneous carburizing, dry cyaniding and clean hardening. (SC-147). Surface Combustion Corp.

(9) Single Drum Hoist

A new 16-page bulletin just released describes the complete line of Joy single-drum, multi-purpose hoists for industrial plants. The bulletin contains complete description and specifications for hoists with capacities from 500 to 3500 lb and driven by "Turbinair," "Pistonair," electric, or gasoline engines. A handy chart simplifies the choice of any hoist to fill a particular need. (76-X). Joy Manufacturing Co.

(10) Disconnecting Switches

A complete line of indoor and outdoor air-disconnecting switches is described in a new 8-page booklet recently released. The booklet gives highlights on the design and operation of these switches, as well as application information to simplify selection. References to more detailed literature are included. Switches listed include five outdoor types and two indoor types. Hookstick operated switches, both outdoor and indoor types for use when single-phase operation is permissible are covered. Other types described are for gang-operation, with or without arcing horns, for interrupting small magnetizing and charging currents and for no-load applications. Rotating- and tilting-insulator types of switches are shown and their applications described. (B-4726). Westinghouse Electric Corp.

(11) Steel Mill Maintenance

Just published is a new cleaning and maintenance brochure entitled "Steel Mill Maintenance" which contains information on steel mill maintenance cleaning operations. The operations and methods contained in this brochure has been tried and proved in numerous steel mills. Typical operations are: cleaning of neglected equipment, air conditioning units, periodic cleaning of bearings, housings, axles, etc., as well as more general operations. The brochure features two case histories; one on economical and efficient bearing cleaning which is very complete and applicable to all mills, the other on cleaning of filter screens, bearing cages and chucks. The operation illustrated in the latter case history resulted in a saving of over $40,000 per year to one mill. Du Bois Co.

(12) Tool Crib Control

A new bulletin is available describing a step-by-step procedure to prevent theft, hoarding and loss of tools, gages, etc., loaned to employees; cut crib inventories; eliminate delays from missing tools; reduce breakage and otherwise speed service and cut costs. (A-510 Rev.). McCaskey Industrial Controls.

(13) Safety for Oilers

Just printed is a "safety chart for oilers." It is printed on heavy card stock suitable for hanging in a prominent position, and lists 15 "things to remember" when lubricating machinery. Copies of the chart are available. New York & New Jersey Lubricant Co.

(14) Carbide Rolls

Recently issued is a new 16-page engineering manual covering use and application, roll design, operating procedure, grinding instructions, advantages, and physical and mechanical properties of tungsten carbide rolls for cold rolling metals. (CR-50). Metal Carbides Corp.

(15) Recording Gages

Just published is a 32-page bulletin on recording gages. Complete information is given on pressure gages for ranges from 0 to 2 in. of water to 0 to 10,000 psi, vacuum gages, low range draft and pressure gages, barometers, and absolute pressure gages for ranges as low as 0 to 6 mm of mercury absolute. Measuring elements, operating principles, recording charts and accessories for the various types of recording gages are fully described. Information is also included on Bristol instruments for automatic controlling and telemetering of pressure and vacuum values. In addition to numerous photographs, the bulletin is liberally illustrated with reproductions of actual chart records and sketches of applications of the instruments. (G621). Bristol Co.

(16) Speed Reducers

Recently released are four new engineering bulletins illustrating and describing the improved Falk parallel shaft speed reducer and the right angle speed reducer (both horizontal and vertical). These standard speed reducers feature precision cut herringbone double helical gears and are available with sleeve bearings or roller bearings, depending upon applications requiring them. Right angle speed reducers are furnished with spiral bevel precision cut helical gears. The vertical right angle units are equipped with a patented oil pump which assures positive lubrication at all times. Right angle units are equipped with anti-friction bearings. These speed reducers are designed for a wide variety of power transmission requirements for almost every industry, and are rated according to the standards of American Gear Manufacturers Association. (1110, 1115, 2105 and 2110). Falk Corp.

(17) Corrosion Proof Cements

Publication is announced of a new bulletin on corrosion proof cements. This bulletin describes Atlas' complete line of resin, sulphur, silicate and asphaltic cements. Information on each cement is compiled in handy chart form which is helpful in the selection of the correct cement for a specific application. Included in the bulletin is information on "Alkor 5E" the nearest thing to a universal corrosion-resistant cement. It is inert to all solvents, alkalies and non-oxidizing acids; no appreciable shrinkage on setting; no obnoxious odors; excellent workability; easily tooled; adhesion to wire cut brick greater than 500 psi; tensile strength 1500 psi; compressive strength 15,000 psi; heat accelerates setting only; no fumes or smoke; sets in less than 24 hours at 70 F. (5-1). Atlas Mineral Products Co.

(18) Lubrication

"The Brooks Oil Story" is the title of a 20-page booklet published by Brooks Oil Co. Manufacturing techniques and production facilities of the 74-year old grease and oil compounding firm are arranged in the form of a picture tour. Included in the booklet are details on a variety of Brooks "Leadolene Klingfast" products, plus information on the planning procedure, research and development facilities and plant equipment. In addition, there are two dozen case

histories of how Brooks products have performed in a variety of industries.

(19) "Stud Welding . . .
. . . in the Steel Industry" is the title of a new booklet just published. The folder contains a step-by-step description of the use of end-welded studs in open hearth doors, and also includes estimated cost savings and production increases possible when studded and rammed doors replace brick doors. Also included in the booklet are sketches and application data based upon the use of stud welding in such steel mill applications as skid tubes, craneway clips, oil burner tubes, and slab reheating furnaces. The Nelson topside method of installing roofing and siding materials is also described in the folder. Nelson Stud Welding division of Morton Gregory Corp.

(20) Proper Marking
"An Easy Guide to Proper Marking," which illustrates and describes various methods and equipment used in marking products of all types and sizes, is a new bulletin available to you. (LI-M). Jas. H. Matthews & Co.

(21) Phosphate Coatings
A new 12-page phosphate coatings bulletin is available. This bulletin gives detailed information about the complete line of ACP phosphate coating chemicals for: paint-bonding; rust proofing; protecting friction surfaces; and improving drawings and extrusion. (915). American Chemical Paint Co.

(22) Goggle Valve
A new replacement section for the Brosius catalog is available on the new Brosius-Westling goggle plate valve. This new section describes many improvements in design which have been made. A few of these improvements are: (1) heavy structural steel construction, (2) valve frame and barrel are separate, (3) valve seats are double with a grease space between them, (4) plate seats are machined plate steel, (5) jack differential screws are high grade chrome-nickel steel, (6) goggle plate is counterbalanced, (7) increased power, (8) no supporting structure or piping is needed. (2B). Edgar E. Brosius Co.

(23) Rolling Mill Machinery
A booklet is available describing Birdsboro rolling mill machinery. The bulletin lists equipment designed by Birdsboro and in operation in plants throughout the world. All equipment is custom-built to meet customers' requirements. The booklet covers equipment for blooming, slabbing, billet, rod, merchant, bar, structural, sheet, strip, plate, tube, rail, and many other kinds of complete rolling mills. It tells why the experience of the engineering staff qualifies them for the design and construction of complete rolling mills. Every rolling mill supervisor should have this booklet in his file. Birdsboro Steel Foundry and Machine Co.

(24) Dihedral Couplings
A booklet is available describing one of the most sensational coupling developments in the past 30 years. This new coupling provides design engineers, installation and maintenance men with a revolutionary new flexible coupling which adequately handles angular and offset misalignment up to 7 degrees with a standard coupling. The booklet tells what the new coupling does, how it is made, how to order, and other information of a technical nature. (50). Ajax Flexible Coupling Co., Inc.

(25) Weekly News Letter
A weekly news letter containing information of interest to engineers and operating executives in the steel industry is available to you. Published by Demag, Duisburg, a German manufacturer of steel mill equipment, the news letter is printed in English. It describes advances in equipment for iron and steel making, harbor and transportation, power plants, and hundreds of other phases of steel mill engineering and operation. The company publishing the news letter supplies many different kinds of machinery as well as construction of complete plant facilities. Kurt Orban Co., Inc. (American Representative).

(26) Not Mere Crayons
With the development of highly specialized crayons for distinctive uses throughout every kind of plant, industrial markers are no longer looked upon as mere crayons but as "tools of production." The "Industrial Crayon Guide" shows the many different kinds of crayons and their multiple uses, and tells the manufacturer which marker to choose for any purpose or surface. American Crayon Co.

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ITEM	COMPANY	BULLETIN	DESCRIPTION
50	AMERICAN AIR FILTER CO., INC.	BULLETIN 250.	Describes the advantages of American Air Filter's "Electro-Matic" installations.
51	BAILEY CO., WILLIAM M.		Bulletin gives full information on all Bailey pug mills.
52	BEDFORD FOUNDRY AND MACHINE CO.		Catalog available on Bedford cranes.
53	BLOOM ENGINEERING CO., INC.		Bulletins available on Bloom's combustion equipment for industrial furnaces.
54	BROWNING AND CO., INC., VICTOR R.	BULLETIN "S".	Describes Browning mill type cranes.
55	CITIES SERVICE OIL CO.		Complete details on combustion control.
56	DE LAVAL STEAM TURBINE CO.	CATALOG 05-16-R.	De Laval's heavy duty blowers.
57	ELECTRIC CONTROLLER AND MANUFACTURING CO.	BULLETIN 942-A.	Describes EC&M tab-weld plate resistors.
58	ELECTRIC CONTROLLER AND MANUFACTURING CO.	BULLETIN 1190-A.	EC&M cam-type master switches.
59	FARREL-BIRMINGHAM CO., INC.	BULLETIN 115.	Farrel grinder.
60	FARVAL CORP.	BULLETIN 25.	Farval centralized lubricating system.
61	FAWICK AIRFLEX CO., INC.	BULLETIN 300.	Advantages of Fawick industrial clutch and brake units.
62	FURNACE ENGINEERS, INC.		F.E.I. service, complete from plan to production.
63	GENERAL ELECTRIC CO.	BULLETIN GEA-4654.	G-E mill motors.
64	GENERAL ELECTRIC CO.	BULLETIN GEA-3083.	G-E metal-clad switchgear for high-voltage applications.
65	GENERAL ELECTRIC CO.	BULLETIN GEA-4469.	G-E unit-cooled, d-c motors.
66	HAYS CORP.	BULLETIN 48-750.	Covers heat-treating furnaces. Companion edition covering open-hearth furnaces also included.
67	HOMESTEAD VALVE MANUFACTURING CO.	39-3.	Complete details on Homestead valves.
68	JOHNS-MANVILLE.		Precision-moulded clipper seals.
69	KOPPERS CO., INC.		Fast's couplings.
70	LEEDS AND NORTHRUP CO.	FOLDER EM9-420(1).	New "Speedomax" 2-function recorder.
71	LESLIE CO.	BULLETIN 464.	Leslie temperature regulator.
72	LINK-BELT CO.	CATALOG 2550.	Complete line of Link-Belt ball and roller bearings.
73	LINTERN CORP.	BULLETIN 4912.	Lintern "Aire-Rectifier."
74	MATHEWS CONVEYER CO.		Mathews conveyer service.
75	NATIONAL BEARING DIVISION, AMERICAN BRAKE SHOE CO.		Complete facts on N-B-M "Tiger" bronze.
76	OAKITE PRODUCTS, INC.		Oakite "CrysCoat" process.
77	PITTSBURGH LECTROMELT FURNACE CORP.	BULLETIN 7.	Gives details on furnaces and their accessory equipment.
78	POOLE FOUNDRY AND MACHINE CO.		Flexible couplings.
79	POST-GLOVER ELECTRIC CO.	BULLETIN 500.	P-G steel grid resistors.
80	REPUBLIC FLOW METERS CO.	DATA BOOK 702.	Republic flow meter.
81	SPRAYING SYSTEMS CO.	DATA SHEET 4516.	Spraying systems and spray nozzles for steel mill application.
82	SQUARE D CO.	BULLETINS 7950 AND 9052	Pneumatic timer and its uses.
83	TAYLOR CHAIN CO., S. G.	BULLETIN 12A.	TM alloy steel chain.
84	TIDE WATER ASSOCIATED OIL CO.		Handbook describes the basic tests used to determine properties of oils and greases.
85	WALDRON CORP., JOHN.	CATALOG 57.	Construction and operating advantages of Waldron couplings.
86	WESTINGHOUSE ELECTRIC CORP.	BOOKLET B-4595.	Westinghouse d-c motor.
87	WESTINGHOUSE ELECTRIC CORP.		Westinghouse d-c Type M contactor.

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Book Reviews

▲ **Hochofen-Schlacke** (Blast Furnace Slag) by Fritz Keil, 346 pages, 6.4 x 9 in., 107 illustrations, and 79 tables, 32.50 Marks, published by Stahleisen, Dusseldorf, Germany. Keil's book is very much more complete than the well-known older book by Guttmann on the same subject (published 1919 and 1934). Slags of all types and compositions are described.

The whole book is well illustrated, both by line-drawings and by halftones. A very extensive bibliography is given.

"Hochofen-schlacke" was written with the usual German thoroughness. It is interesting to learn from this book how much is to be known about the properties, use, and testing of blast furnace slag and of the products made from it.

▲ **Modern Refractory Practice** has just been issued in a third edition by the Harbison-Walker Refractories Co., Farmers Bank Bldg., Pittsburgh 22, Pa., 8 x 11 in., 440 pp. This book is an encyclopedia on refractories. It combines a practical engineering handbook, a detailed technical treatise and a catalog of the company's products all in one volume. Although it follows the general outline of the second edition which was published in 1937, it has been increased almost 50 per cent in size. Among the outstanding features of the book are scale drawings of 20 types of furnaces which illustrate modern industrial practice. These drawings show in detail, not only the design of the furnace, but the types of refractories generally used as well as alternate types for special operating conditions. Other chapters include one on suggestions on the care and use of refractories, another on arch construction and design and another on refractory properties. This book is offered without charge to users of refractories. For general distribution a charge is made which is less than the cost of preparation. Requests for the publication should be sent to the Harbison-Walker Refractories Co.

▲ **Fundamentals in the Production and Design of Castings** by Clarence T. Marek is a new book which may be obtained from John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., cloth bound, 359 pp, 5⅜ x 8¼ in., price $4.00. For an engineer to design engineering parts he must design the part so that it will perform a certain function and also so that it may be produced with least expense of labor and material. In order to do this the engineer must be familiar with the production process. This book deals with casting problems so that the design engineer will have a better knowledge of the background and thus avoid unnecessary waste of labor and material.

▲ **Stress and Strength of Manufactured Parts** by Lipson, Noll and Clock, is directed to designers, engineers and metallurgists who deal with problems of stress strength and the prevention of failures of parts and assemblies. The book is divided into two parts. The first part deals briefly with the general principles underlying the basic concepts of the balance between stress and strength. The second part deals with stress and strength data and gives stress concentration factors and allowable stress data. Published by McGraw-Hill Co., 330 W. 42nd St., New York 18, N. Y., cloth bound, 5¾ x 8¾ in., 233 pp, price $4.50.

▲ New 9th Edition "**Procedure Handbook of Arc Welding Design and Practice,**" revised and re-edited, new information and data added, including latest welding procedures, design data and techniques; recognized the world over as the authoritative source of information on arc welding design and practice; over 1200 pp, 1300 photographs and drawings; size 6 x 9 in.; bound in semi-flexible, gold embossed, simulated leather; price $2.00, postage prepaid, in the United States; $2.50 elsewhere.

Latest procedures are given for welding all metals and alloys commonly welded with manual open arc and hidden arc welding as well as automatic and semi-automatic hidden arc welding.

A completely new chapter on weldability has been written to present a comprehensive survey of this important subject.

▲ **New G-E Manual of Instrument Transformers Now Available.** A profusely illustrated, 76-page manual, GET-97A, covering the theory of operation and the application of instrument transformers has been announced as available by the General Electric Co.'s Meter and Instrument Divisions.

Priced at $1.00, the new Manual of Instrument Transformers is written for practicing engineers and students engaged in the fields of power generation, transmission and application where metering and relaying problems can be solved by the correct application of instrument transformers.

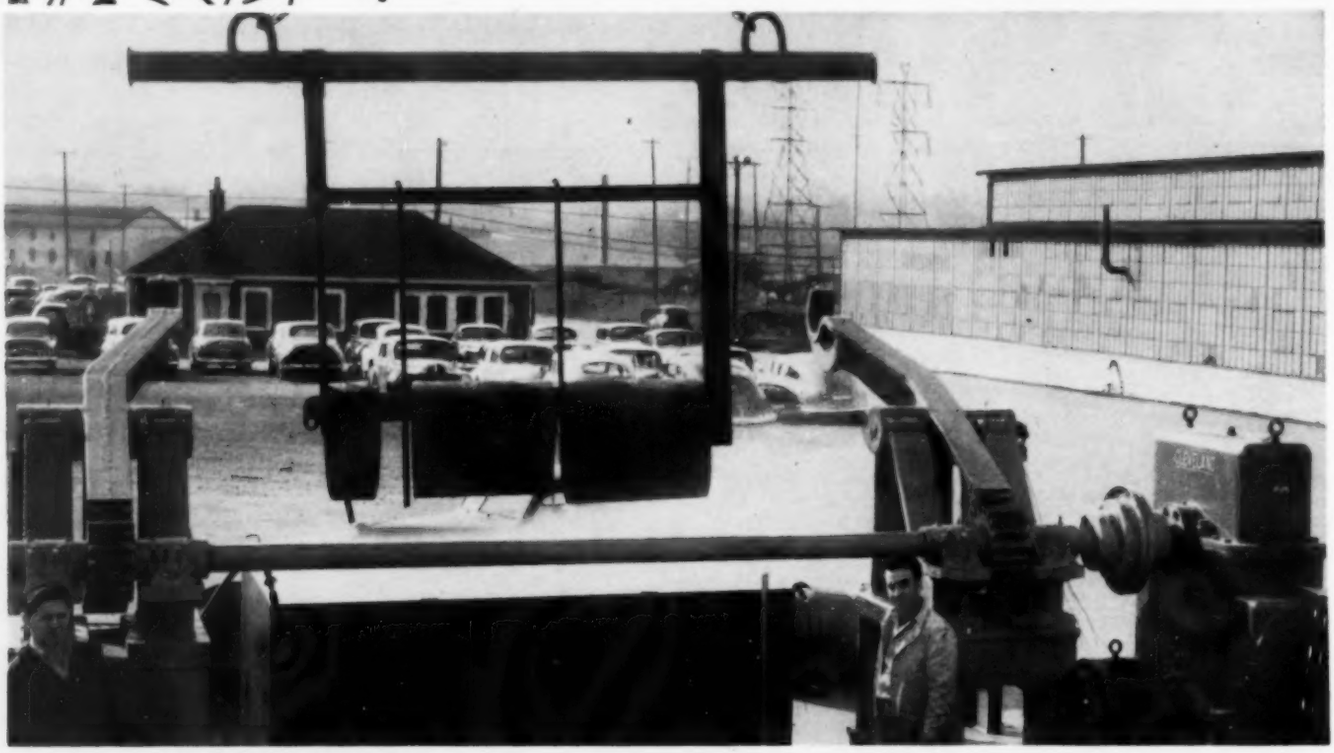
The manual covers the basic fundamentals of instrument transformers, such as accuracy standards, insulation and polarity. In addition, it gives complete information on potential and current transformers, including operating principles, types and ratings, applications, circuits, fusing, etc.

▲ **An American Standard Gear Nomenclature, Terms, Definitions, and Illustrations,** B6.10-1950, has just been approved by the ASA. To help bring about use of uniform terminology in offices, shops, and textbooks, this standard was prepared by a committee representing manufacturers, users and independent experts. It provides a system of terms and their meanings grouped as a logical series rather than in alphabetical order. It also includes illustrative figures which can be referred to in investigations and discussions of gear problems.

The standard was developed by a committee jointly sponsored by the American Gear Manufacturers Asso-

(Please turn to page 202)

A LOW-COST COIL PICKLER DESIGNED ESPECIALLY for MEDIUM and LOW-TONNAGE MILLS



THE WELDCO MECHANICAL COIL PICKLER

SAVES SPACE • SAVES TIME
CUTS OPERATING and MAINTENANCE EXPENSE

Here, at last, is an economical, space-saving Coil Pickler, built especially for smaller mills that do not have continuous pickling. The Weldco Mechanical Coil Pickler handles strip, rod, or wire coils quickly and easily, requires very little space, cuts manpower, maintenance and operating expense 20% to 40%!

LOW INITIAL COST

A fraction of the cost of a Continuous Pickler.

No elaborate fume removal system is needed.

Only small pickling and wash tanks are required.

Less auxiliary equipment to install because, in the Weldco set-up, the coil is not uncoiled, then recoiled.

LOW MAINTENANCE COST

Simple, fool-proof mechanism — designed for maximum efficiency.

No damage or wear on tank, because the coil never touches the tank.

LOW OPERATING COST

Less steam consumption, because of the smaller tanks.

Less manpower needed.

Greater flexibility — several different widths can be pickled at the same time.

No down-time, because there's no resetting of equipment for different sizes.

No hairpinning required — another big time-saver!

SAVES PICKLING TIME

The up-and-down, side-to-side motion of the coil in the pickling bath removes the loose scale quickly, resulting in a completely clean, uniformly pickled surface.

The Weldco Mechanical Coil Pickler is available in any capacity, to meet your individual requirements. (For successful pickling of strip, a satisfactory scale breaker and a loose coiler are required.) Contact our Engineering Department for complete details on this new, low-cost Mechanical Coil Pickler — for complete engineering service on your entire pickling line.

THE YOUNGSTOWN WELDING & ENGINEERING COMPANY

3706 OAKWOOD AVENUE · · · YOUNGSTOWN 9, OHIO

Wellman will build it

- Special Cranes
- Gas Producer Plants
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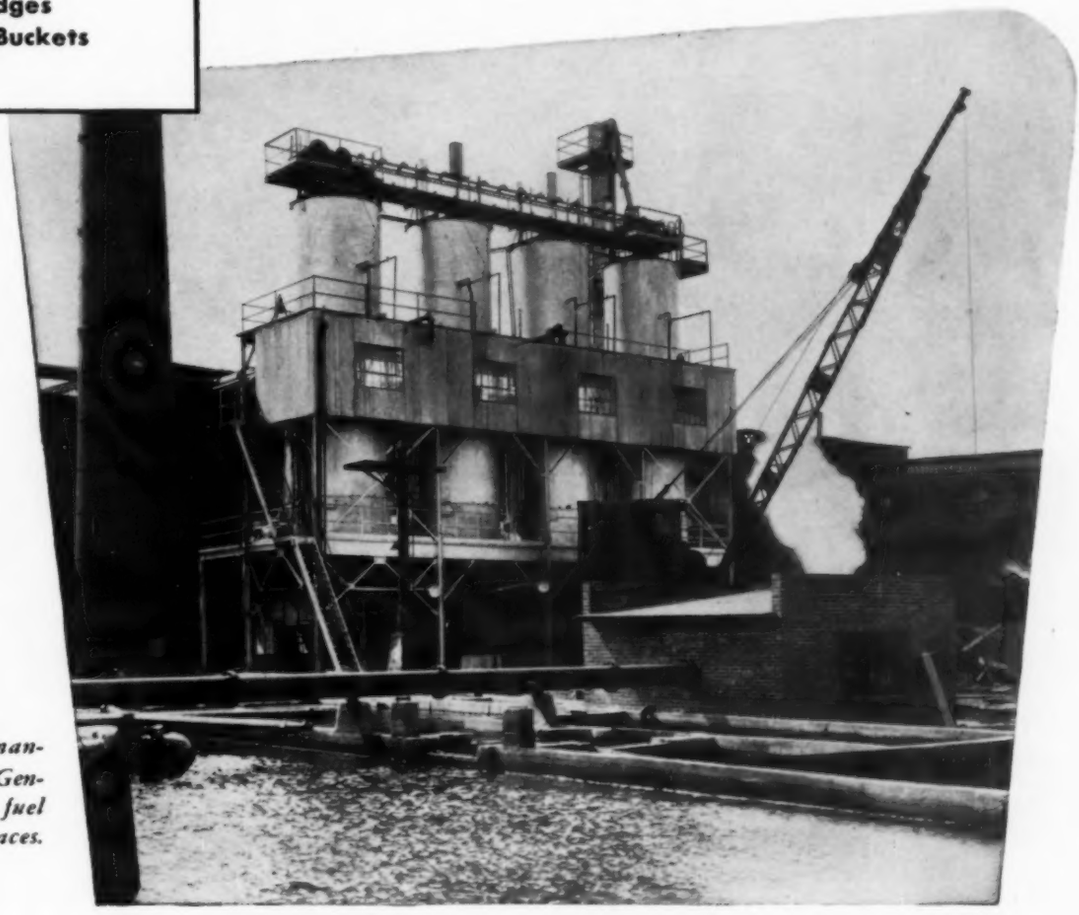
Wellman-Galusha Clean Gas Generators

Built exclusively by Wellman

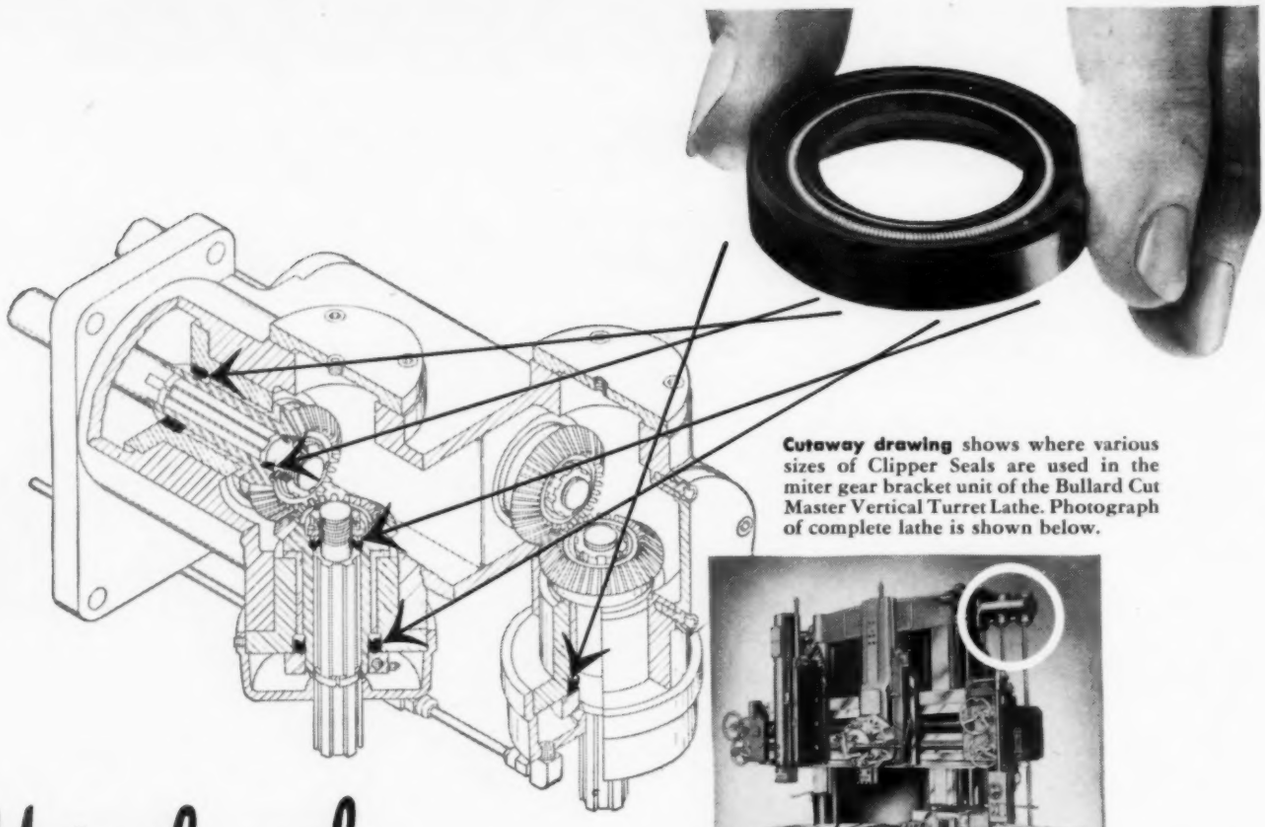


Four 10 ft. Wellman-Galusha Clean Gas Generators supplying fuel for steel mill furnaces.

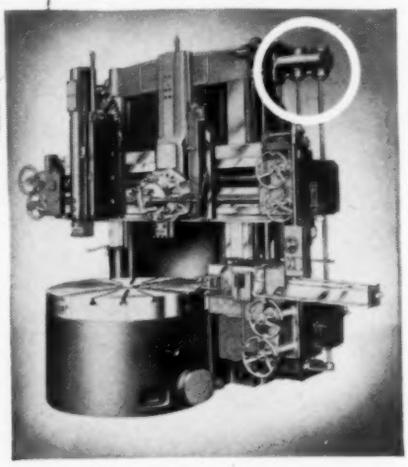
• Only Wellman builds the Galusha Clean Gas Generators that so ideally meet your requirements with efficiency and economy. These generators combine, in a *complete* machine, the rotary grates, ample fuel storage bin, and provisions for generating the steam required for making the gas. Even the lowest-priced grades of Anthracite and coke can be satisfactorily gasified.

THE WELLMAN ENGINEERING COMPANY

7031 CENTRAL AVENUE • CLEVELAND 4, OHIO



Cutaway drawing shows where various sizes of Clipper Seals are used in the miter gear bracket unit of the Bullard Cut Master Vertical Turret Lathe. Photograph of complete lathe is shown below.



Hot oil seals the problem?

...The Bullard Company finds Clipper Seals the answer

A seal to fit any cavity

To assure maximum freedom of design, Clipper Seals are available with flanges of various thicknesses, as shown above. The light flange section (right) permits the designing of oil seal cavities with depths as small as ¼".

PERHAPS you have a "hot" sealing problem similar to that faced by The Bullard Company, Bridgeport, Conn. . . . one of the world's leading producers of high quality machine tools.

Here's how they solved it with Clipper Seals.

The above drawing shows one of many locations where Clipper Seals are used in Bullard Cut Master Vertical Turret Lathes. To assure highest efficiency from the full range of 16 feeds in geometric ratio for each head, each seal must function perfectly without overheating.

Various other oil seals were tried and found wanting before The Bullard Company tested Clipper Seals and found them ideal because their simple design minimizes friction and wear . . . thereby always assuring cool, trouble-free operation and an unusually long service life.

You, too, will find that Clipper Seals not only end your overheating problems, but also do a highly efficient job of keeping lubricants in place . . . and dirt and abrasives out. That's because the tough, dense heel of the Clipper Seal has the rigidity necessary for a press fit in the cavity . . . while the flexible lip, held in light but positive contact with the shaft by a specially designed garter spring, provides perfect sealing at all times.

Precision-moulded Clipper Seals are available in a variety of designs, in sizes to fit shaft diameters from ¼" to 66", for temperatures to 450F, and for shaft speeds to 3500 rpm. Get complete information by writing for Brochure PK-46A. Address Johns-Manville, Box 290, New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville CLIPPER SEALS

Says the Superintendent of a large Process Industries Plant:

This plant's experience is typical of that of thousands of other users, and tells why Homestead Lever-Seald Valves have been first choice for more than 18 years for services where corrosive fluids, slurries, abrasives, or extremes of temperature or pressure cause ordinary valves to fail.

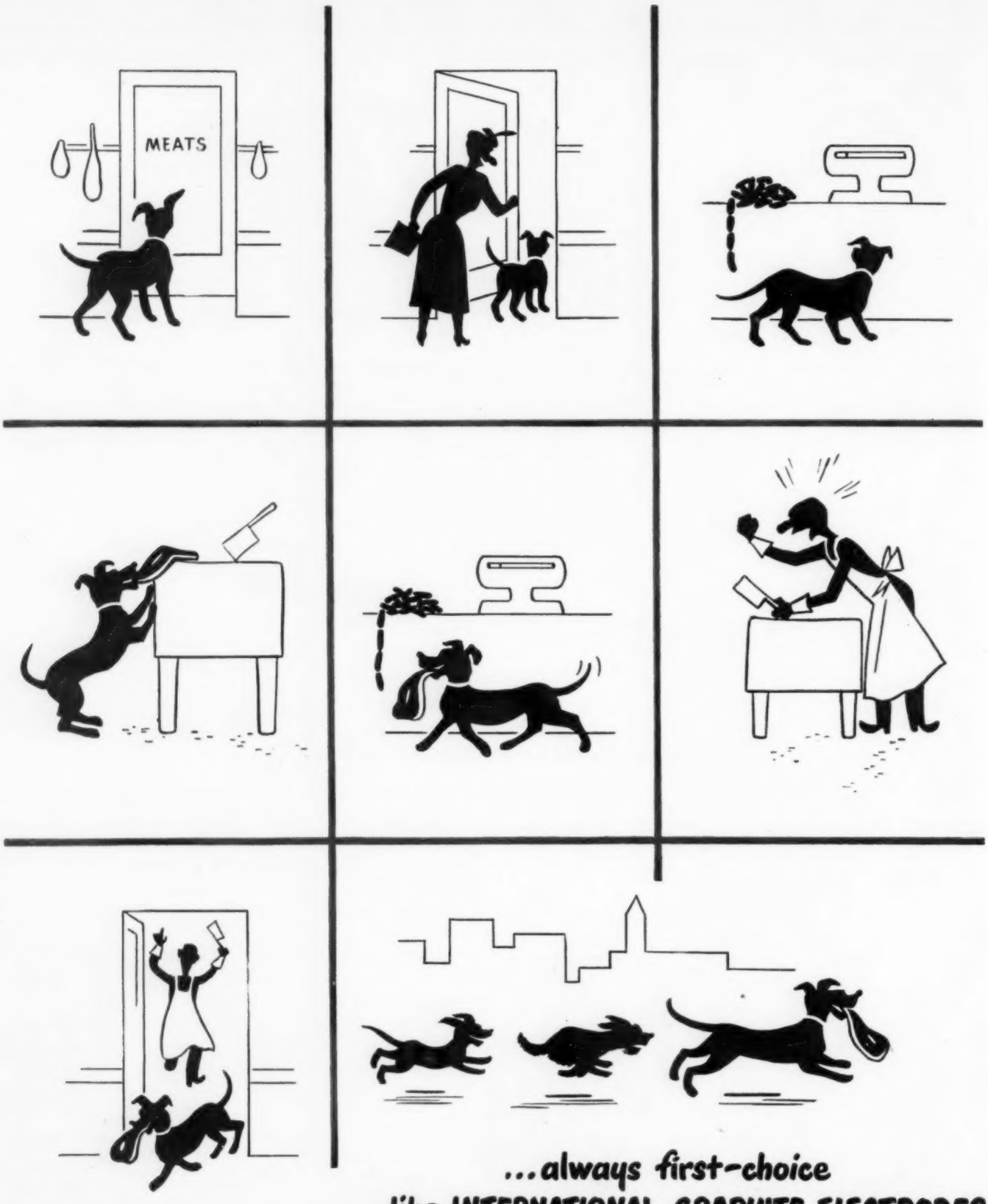
Homestead Lever-Seald Valves are stick-proof; require less maintenance; and the means for easy turning under all conditions, is built right into the valve. We can furnish them in stainless steel, steel, iron, brass or alloys to meet your needs; sizes 1½" to 10"; for pressures from vacuum to 1500 lbs.

Write for valve reference book
No. 39-3. No obligation.

HOMESTEAD VALVE MANUFACTURING CO.

"Serving Since 1892"

P. O. BOX 21 CORAOPOLIS, PA.



...always first-choice
...like INTERNATIONAL GRAPHITE ELECTRODES

IGE International GRAPHITE AND ELECTRODE CORP.
ST. MARYS, PA.
6263

God bless you, mister

. . . thousands of Cancer patients are grateful to you!

Cancer's annual toll of 200,000 lives is grim proof of the need for your continued generosity. The money you contribute to the American Cancer Society helps pay for the development of methods of treatment which are now saving about one-quarter of the people who are stricken with Cancer . . . people who might otherwise have died. Your money supports the work of more than a thousand specialists who are fighting to find the cause and cure of Cancer. And it finances a vast education program that trains professional groups, tells the public how to recognize Cancer and what to do about it.

Your life—the life of everyone you know—is at stake. Your investment can mean health and happiness to millions. Thank you . . . and God Bless You, Mister.

just mail it to

CANCER

Just write "CANCER" on the envelope containing your contribution. It will be delivered to the American Cancer Society office in your state.

Assured Quality

The quality of any weld—its strength, ductility, grain structure, machinability, surface finish—depends largely on the rod used to make it. Only the best rods consistently give good welds of uniformly high quality. Only the best can help you to weld better and faster at lower cost . . . and help to make your job easier, too.

There are two good reasons why OXWELD Welding Rods are the best that modern science knows how to make. First, their rigid specifications are carefully worked out in LINDE research laboratories, which are among the largest and best equipped in the world. Second, LINDE engineers at production points constantly check during manufacture to see that the rods conform to these specifications.

They inspect ingots and billets, sample heats for chemical analysis, make flame and weldability tests, weld and test coupons for strength and ductility. In short, every known precaution is taken to maintain a uniformly high standard.

Every OXWELD Welding Rod that goes to market is of proved physical and chemical analysis . . . free from all objectionable properties and impurities. The OXWELD trade-mark is your guarantee of quality and satisfaction.

The terms "Oxweld," "Prest-O-Weld," and "Purox" are registered trade-marks of Union Carbide and Carbon Corporation.

These 5 Rods Handle a Complete Range of Welding

OXWELD No. 1 H. T. Steel

For all high-strength steel welding. Develops tensile strengths 11,000 lb. per sq. in. higher than ordinary steel.

OXWELD No. 7 Drawn Iron

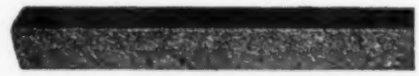
A remarkably ductile, copper-coated rod for all run-of-shop steel welding on materials up to ¼-inch thick.

OXWELD No. 25M Bronze

A superior rod for all braze-welding, building up wearing surfaces, and fusion welding of copper alloys.

OXWELD No. 23 Aluminum

For all-purpose welding of aluminum and its alloys. Prevents weld cracking by absorbing cooling stresses.



OXWELD No. 9 Cast Iron

An ideal rod for fusion welding gray iron castings. Weld metal is fine-grained, soft, and easily machined.

9 additional welding rods and 8 hard-facing rods for more specialized work.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

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THE ENGINEERING MART

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Book Reviews

(Continued from Page 193)

ciation and the American Society of Mechanical Engineers under the procedures of the American Standards Association.

The standard will be available from either the American Standards Association, 70 East 45th St., New York 17, N. Y., or from the American Society of Mechanical Engineers, 29 West 39th St., New York 17, at $1.50 per copy.

▲ **Chemical Reactions in the Basic Arc Electric Furnace** by H. C. Bigge, superintendent, tool steel department, Bethlehem Steel Co., Bethlehem, Pa., 16 pp has just been published. Copies may be obtained by writing the author and the price is $3.00. This book gives reactions that take place in the electric furnace and also gives reaction heats. Data is also given on desulphurization in the basic arc furnace. The pamphlet also gives some reduction tables.

▲ Steel Founders' Society of America has published a new booklet, **"Fundamentals of Steel Casting Design."** Prepared by Charles W. Briggs, technical and research director, as part of the Society's educational program, the booklet comprises a thorough, 32-page primer of fundamental practices useful to designed and foundryman alike. Emphasis is directed particularly to considerations looking to reduced production costs, elimination of unnecessary weight, improved casting quality and castability.

Copies of the booklet may be obtained by writing to F. Kermit Donaldson, executive vice president, Steel Founders' Society of America, 920 Midland Bldg., Cleveland 15, Ohio. The price is 20 cents.

▲ **1949 ASTM Standards on Petroleum Products and Lubricants** brings together in compact, readily usable form, most of the ASTM standards, test methods and specifications widely used in this field. (The methods of test for knock rating of engine fuels are issued in a special manual and not included in this compilation.) Prepared by ASTM Committee D-2 on Petroleum Products and Lubricants, this edition gives in their latest form 120 standards, including 102 test methods, 12 specifications, 2 lists of definitions relating to petroleum and rheological properties of matter, 2 tentative recommended practices for the purchase of uninhibited mineral oil for use in transformers and in oil circuit breakers, and for designating significant places in specified limiting values; and other material. Copies of this 750-page book can be procured from American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., at $5.50 each, heavy paper cover; $6.15, cloth cover.

▲ **Plant Engineering Handbook,** a compendium of industrial know-how which has, until now, appeared only in specialized reference works, was recently published by the McGraw-Hill Book Co., 327 West 42nd St., New York City, 6 x 9 in., 1955 pp, 1487 ill., 544 tables, price $15.00. This handbook tells how to manage, operate and maintain industrial plants, and presents the essentials of good plant engineering practices in 77 major areas of plant operation and maintenance.

William Staniar, editor-in-chief, and the 86 contributing authors, each a nationally recognized authority in his respective field, have worked for 5 years to complete this handbook. It is designed to meet the needs of plant managers, plant superintendents, plant engineers and plant maintenance engineers.

The book deals with industry's consumption and conservation of basic resources, with management engineering, with industrial construction, fire protection, maintenance, with industrial power and its uses, with air handling, materials handling, and the handling of services. Specialized subjects of instrumentation, bearings and lubrication, engineering materials and mechanical power also are presented, plus many others that are vital to efficient industrial and institutional operations. Each of the 77 subjects contained in Plant Engineering Handbook is an individual treatise on the principles observed by the country's leading manufacturing enterprises and on methods these companies find most effective. The tables, formulas and graphs accompanying each subject provide further reference.

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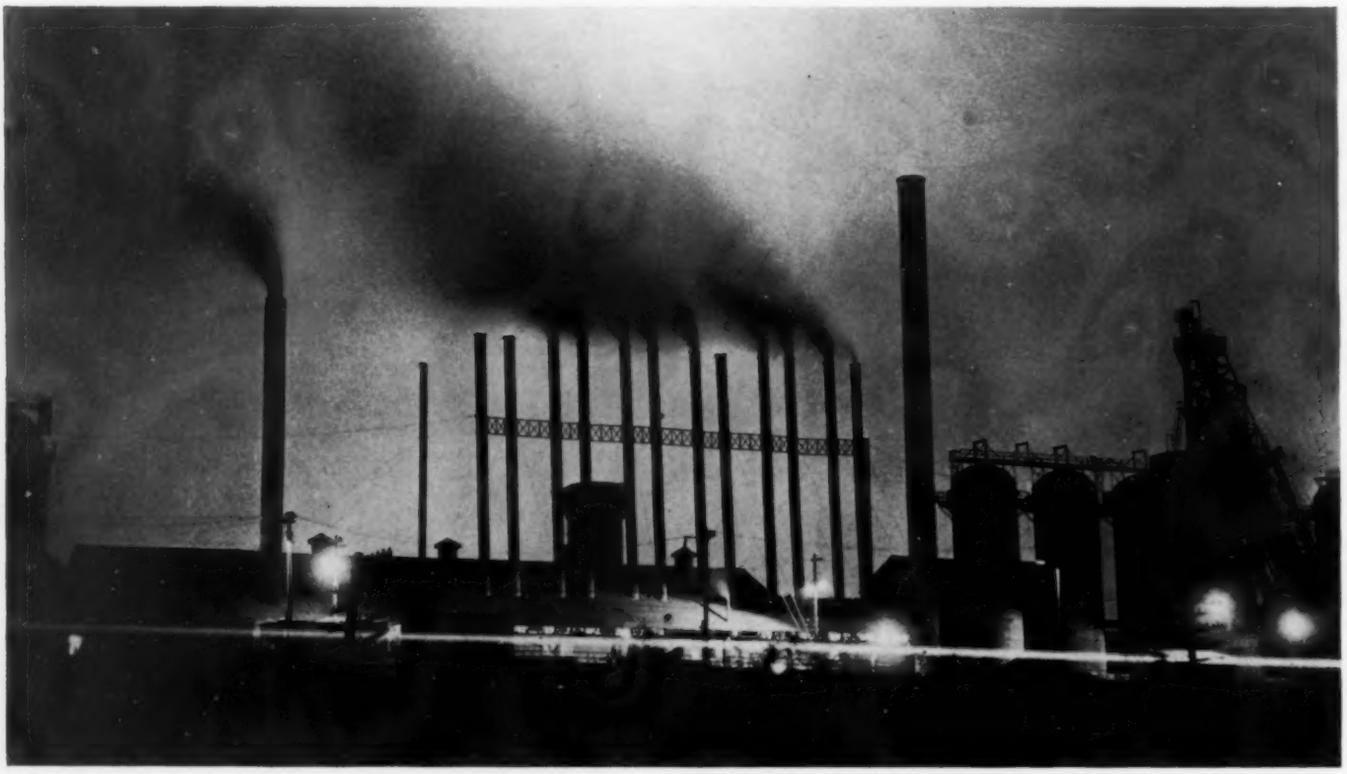

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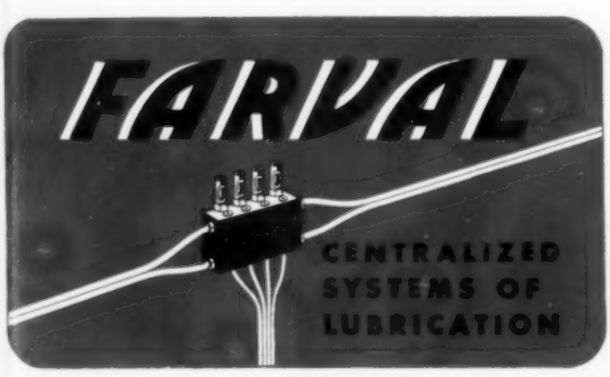

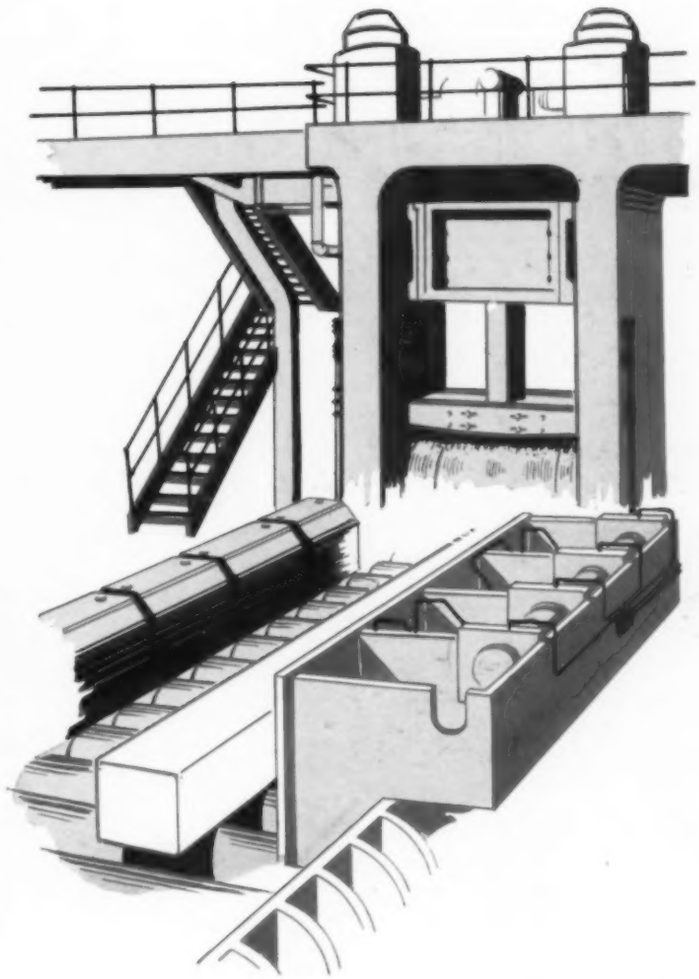

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No. 91

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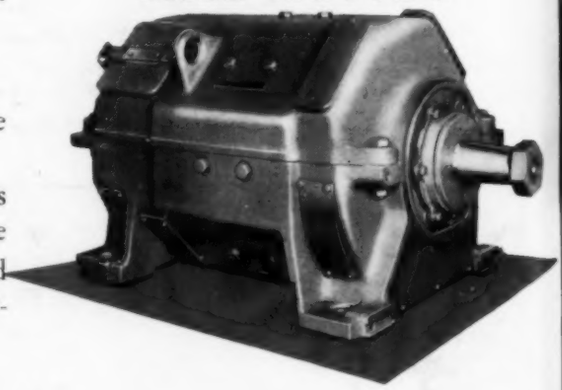

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